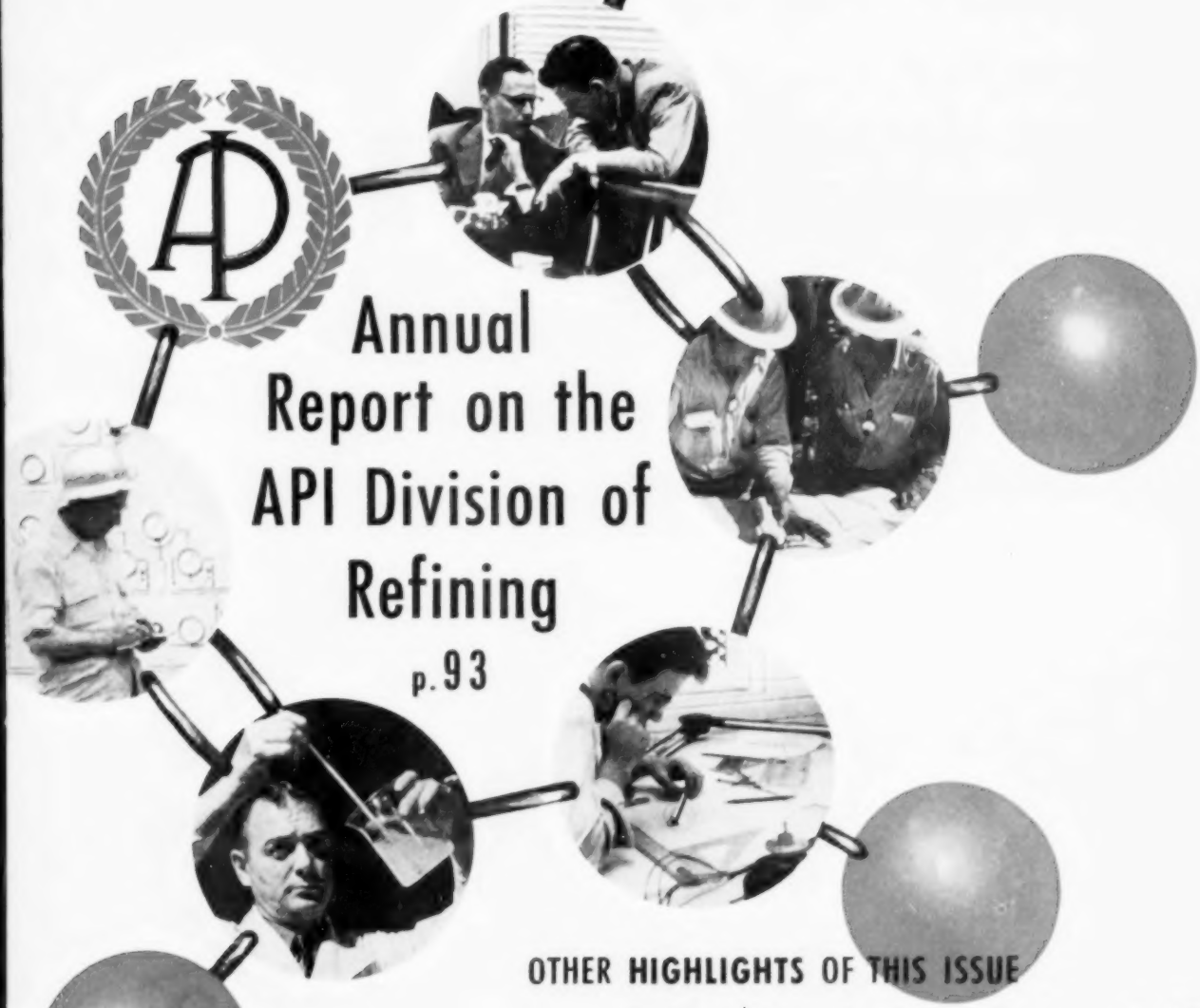
Petroleum Processing

Petroleum Refining • Petrochemical Manufacturing • Gas Liquids Recovery MAY, 1956



Annual Report on the API Division of Refining

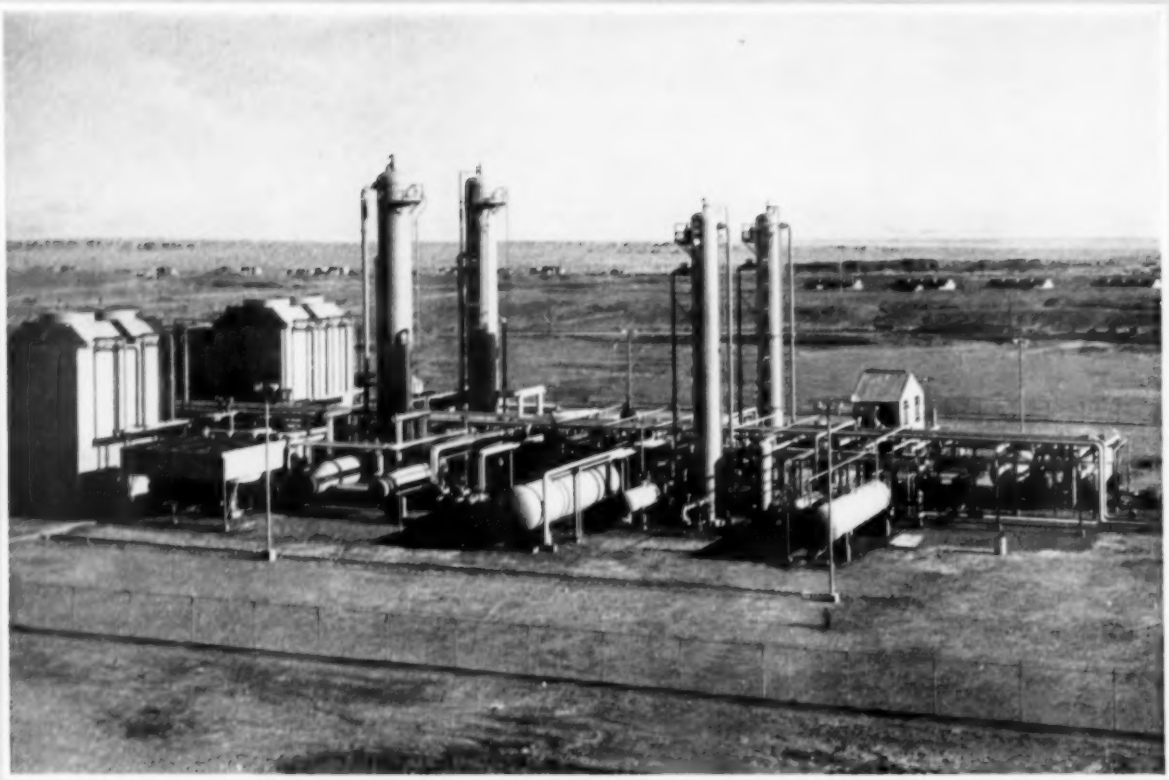
p. 93

OTHER **HIGHLIGHTS** OF THIS ISSUE

Technical Tips for Processors . . . . . p. 65
Adipic Acid via Cyclohexane . . . . . p. 74
Six Tough Turnaround Problems . . . p. 82

PRICE 35 CENTS

McGRAW-HILL PUBLICATION



Sui GAS STARTS TO KARACHI

This plant, the first of its kind in Asia, is located in the Sui Gas Field 350 miles northeast of Karachi in West Pakistan. It processes sour gas, removing sulphur compounds and water vapor, preparing the gas for transportation and consumption. It is a vital part of a project from which will accrue great economic advantage to Pakistan.

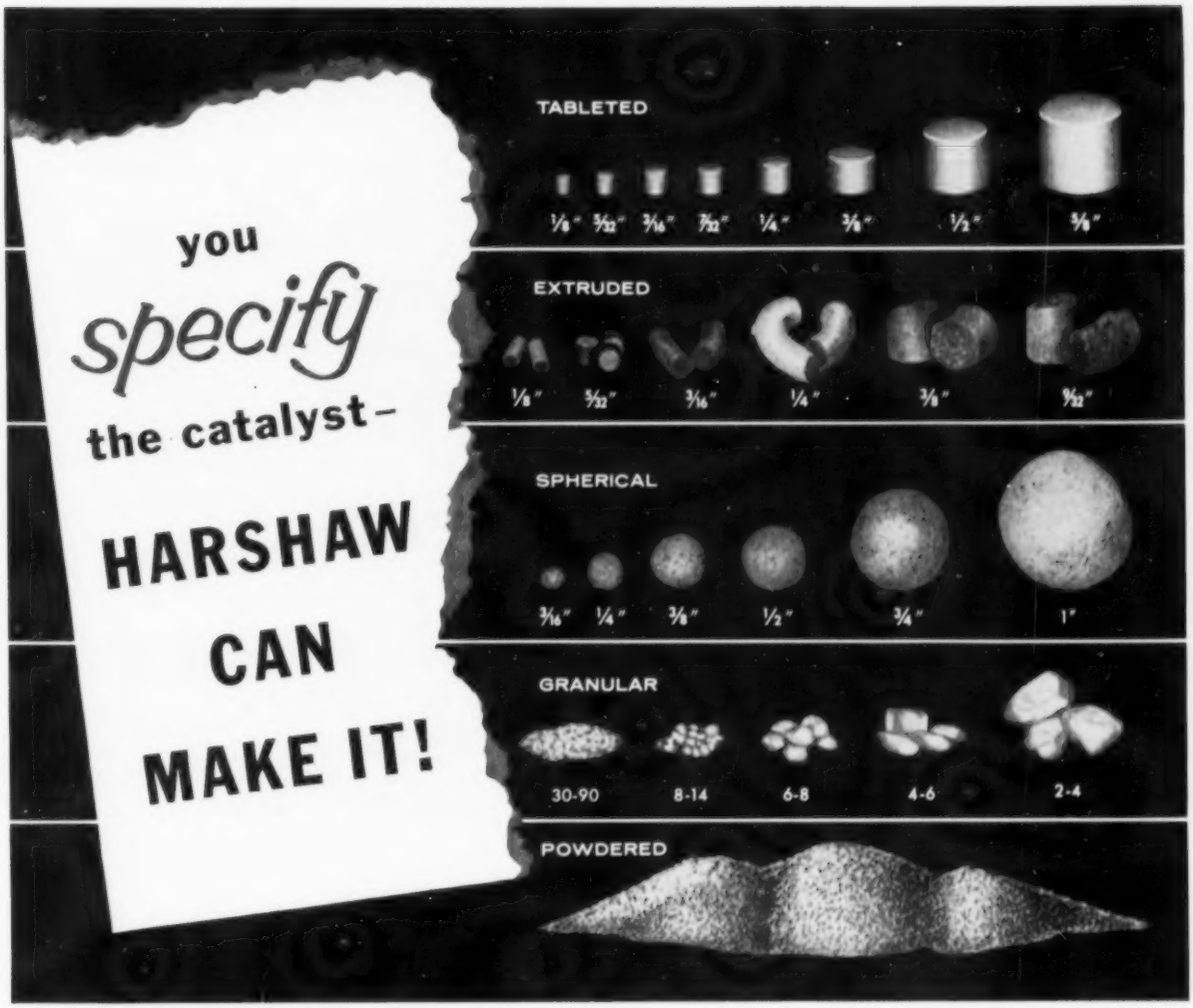
The work of Hudson included design, procurement of equipment, transportation, and erection using English, American and native labor.

Despite the remoteness of the plant site, the rail terminus being 40 miles across the desert, and air temperatures as high as 125 F. in the shade, the plant was completed in 12 months from start of design work.

Hudson is proud to have collaborated with Pakistan Petroleum, Limited, and Sui Gas Transmission Corporation in the successful completion of this first project of its kind in Asia. The experience of Hudson gained in over 30 years in design and construction of oil and gas processing plants in the United States, Europe, Mexico and South America is available for any project large or small in any part of the world.

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS



HARSHAW

has the facilities for producing carload quantities of

PREFORMED CATALYSTS

to fit special process requirements

Hydroforming	Dehydration
Cyclization	Desulphurization
Oxidation	Alkylation
Dehydrogenation	Isomerization
Hydrogenation	

CATALYTIC CHEMICALS SUPPLIED BY HARSHAW

Aluminum Nitrate — Cobalt Nitrate
Copper Nitrate — Manganese Nitrate Solution
Metallic Soaps (Cobalt, Manganese)
Nickel Carbonate — Nickel Formate — Nickel Nitrate
Nickel Sulfate — Sodium Methoxide — Zinc Nitrate

Our experienced technical staff will assist you in developing the best and most economical catalyst. If you have a catalytic process in the development or production stage, a discussion with us may prove beneficial.

Write for FREE Booklet, "HARSHAW CATALYSTS"

HARSHAW

THE HARSHAW CHEMICAL CO.

1945 EAST 97th STREET • CLEVELAND 6, OHIO

Chicago • Cincinnati • Cleveland • Hastings-On-Hudson, N.Y. • Houston • Los Angeles
Detroit • Philadelphia • Pittsburgh

Reader's Guide

What's New in Petroleum

I II III 1 2 3 4 5

SPECIAL THIS MONTH

Our 8th Annual Report on:
The Refining Division
American Petroleum Institute
and its
21st Mid-Year Meeting
Montreal, May 14-17, 1956

Here's what you will find in this special 16-page section:

- **Message from the Vice President,** Refining Division, E. B. McConnell . . . . . **p. 93**
- **Complete Program** – listing all papers scheduled for all sessions, plus a timetable to give you a quick rundown on what's happening, when, where, and what time, plus a helpful guide to all the individual committee meetings . . . . . **p. 94**
- **Your Montreal Hosts** – a picture story introducing your Canadian host committee, the group who has worked a year in preparing for you. **p. 98**
- **Electrical Equipment** – a special story which highlights one of the many interesting group sessions typical of this meeting. . . . . **p. 100**
- **Committee Reports** – the annual roundup of reports by each chairman of the seven technical committees in the Division . . . . . **p. 102**

I 1 2 3 4 5

I II III 1 2 3 4 5

Technical Tips for You

. . . as a processor. The latest information obtainable from today's plant operators. Beginning the 1956 series of articles based on the popular question-and-answer session from Western Petroleum Refiners' Ass'n. fall meeting . . . . . **p. 65**

I 2 3

Here are Your WPRA Friends

. . . as seen and photographed by the PETROLEUM PROCESSING cameramen. Two pages of pictures of petroleum processing technologists who attended the annual meeting of the Western Petroleum Refiners' Ass'n. in San Antonio in March . . . . **p. 70**

I 1 2 3 4 5

How to Lick a Bottleneck

. . . in shipping finished products. The inside story on what Gulf did to solve a handling problem with its new packaged goods warehouse just put "on-stream" at the 245,000 b/d refinery at Port Arthur, Texas. . . . . **p. 72**

I 2 3 5

It's Needed for Nylon

That's one of the important reasons for today's growth in adipic acid manufacture. This story tells why it's important, and how it is made from petroleum as a raw material via the cyclohexane route, by Peter W. Sherwood . . . . . **p. 74**

II 1 2 3

A McGRAW-HILL PUBLICATION

Member of Associated Business Publications and Audit Bureau of Circulations

Petroleum Processing is published monthly by McGraw-Hill Publishing Co., Inc., James H. McGraw (1860-1948) founder.

Executive, Editorial and Advertising Offices: McGraw-Hill Building, 330 West 42nd St., New York 36, N. Y. Publication Office: 871 N. Franklin St., Chicago 10, Ill. Donald C. McGraw, President; Paul Montgomery, Executive Vice-President; Joseph A. Gerardi, Vice-President and Treasurer; John J. Cooke, Secretary; Nelson Bond, Executive Vice-President, Publications Division; Ralph B. Smith, Vice-President and Editorial Director; Joseph H. Allen, Vice-President and Director of Advertising; J. E. Blackburn, Jr., Vice-President and Circulation Director.

Subscriptions: Address correspondence to Petroleum Processing, Subscription Service, 330 West 42nd St., New York 36, N. Y. Subscription rates: domestic single copies, 35c, U. S. and possessions, Canada, and all other countries, $2 per year, $3 for two years, $4 for three years. Orders must indicate company and position.

Published prior to Sept. 1946 as the Technical Section of National Petroleum News, devoted to Refinery Management and Petroleum Chemical Technology, and including International Petroleum Technology.

Second class mail privileges authorized at Chicago, Ill. Printed in U.S.A. Copyright 1956 by McGraw-Hill Publishing Co. Inc. All rights reserved.

Processing for May, 1956

I II III 1 2 3 4 5

Better Supervision of Engineers

Handling the technical man today takes special skills to make the most of his abilities. Here are some of the reasons why good supervision of engineers is so important – and some practical tips on how to get results. . . . . p. 80

I II III 2 3 4 5

Men and Tools–two 'musts' for solving . . .

Six Tough Turnaround Problems

How Lion Oil Co.'s El Dorado refinery met and licked them, as told by Lion's mechanical superintendent, J. B. Adams, who said this was "the best executed and planned turnaround in our refinery history." . . . . . p. 82

I 3 4

How Can Octanes over 100 be Rated?

A new scale has been proposed for rating gasoline above 100 octane. Here's the story on who did the development, how the work was done, a description of the new scale, and some of the objections which have been raised. . . . . p. 90

I 1 3 5

I II III 1 2 3 4 5

Bubble-Cap Tray Design — Part IV

The final installment of the first truly complete manual of new process design methods for optimum bubble-cap tray design, prepared exclusively for you, by William L. Bolles, Monsanto Chemical Co.

This month Mr. Bolles brings together the techniques described in the first three installments of his article, and develops an example of a bubble-cap tray design problem in detail, showing how to apply the principles and avoid pitfalls. . . . p. 109

I II III 2 4

AND WHAT'S AHEAD

More Information-Packed Issues

You will find it pays to keep your eyes peeled for your copy of PETROLEUM PROCESSING every month.

Upcoming issues – some soon, others later on – will bring you articles on these subjects:

- Instruments for high pressure processes
- New ideas for reducing operating costs
- The basics of linear programming
- Quality requirements for jet fuels
- A special report on evaporation losses

DEPARTMENTS

Advertisers' Index 174
Book Reviews 167
Editorials 208
Engineering Data Sheet . . 141
Equipment—What's New! . 177
Information Offered 172
Letters from Readers 18
Meetings for Oil Men 155
New Words 139
Operating Trends 169
Patents 159
Personals 145
Plant Practices 133
Process Data Sheet 139
Publisher's Page 7
Readers' Service Card 175
Statistics 169
Suppliers 149
Tomorrow 13
What's Happening 9
What's New! 177

Continue "Readers' Guide" on p. 125

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —THE EDITORS

. . . many refiners are still trying to catch up . . .

About your top octanes . . .

Refinery Consultant Melvin Gertz answers your questions about the industry's hottest subject

As a service to the refining industry, Ethyl Corporation asked Refinery Process Consultant Melvin Gertz* what can be done to control the increasing cost of top octanes! Here is the interview:

Q. *Are we approaching the end of our present cycle of refinery expansion and modernization?*

A. No. Many refiners are still trying to catch up with the demand for petroleum products. At the same time, two problems have necessitated more building: (1) a leveling out in the market for heavy fuel oil, and (2) octanes have steadily increased.

Q. *How is the industry solving these two problems?*

A. Refiners have accomplished the reduction in fuel-oil yield by installing new cat crackers, increasing coking installations and expanding asphalt production facilities. And fortunately, the addition of cat crackers has also considerably helped in meeting the demand for higher octanes.

However, octane increases have made refiners look to other processes and so that's why we have witnessed a wave of catalytic reforming installations over the past few years.

Q. *What would you say is the major problem that refiners are trying to meet?*

A. Certainly, today, the major emphasis is on filling the need for higher octane fuels.

Q. *Is expansion planning more difficult for the refiner today than, say, ten years ago?*

A. Yes, it is. Although we now have more processes to choose from and our technology for dealing with problems has improved, the industry has reached the octane level where each step requires careful analysis. Moving above the 98 octane level into the 100 plus octane range is expensive, no matter how you do it, and, in some instances, the end products are quite different.

Q. *In your opinion, what processes should a refiner consider in the 98 to 100 plus octane range?*

A. High-severity catalytic reforming, alkylation, isomerization—and combination processes such as catalytic reforming followed by extraction and thermal reforming. All of these processes have their own merits, and in a given refinery each would result in a different combination of gasoline yields and octane ratings.

Q. *Even with the differences in processes, isn't the problem still a matter of finding the cheapest way to produce 100 plus octane gasoline?*

A. No. It just isn't that simple. In some of the newer cars, the engines are relatively mild so that the road octane rating very closely follows the research octane rating. But for many of the new cars, there's some depreciation in road performance below the research rating.

Therefore, in planning octane improvement processes for the future, much consideration must be given to

. . . each step requires careful analysis.

*A partner of Purvin & Gertz, Dallas, Texas.

(To obtain more data on advertised products see page 174)

hydrocarbon composition and performance in vehicles as well as to the primary objective of ratings made in the laboratory.

Q. *Are there any other factors in process selection?*

A. Yes. The next factor to be considered is volatility. In some companies there is a definite trend to high volatility gasoline which necessitates removal of many higher-boiling-point top-octane components such as polymer gasoline and heavy cat naphtha from the premium blends. If this trend continues, it will have a significant effect on the selection of future processes. In other words, in addition to merely research octane ratings which have been the primary yardstick for the past few years, economic considerations at this time must be weighed

Moving above the 98 octane level into the 100 plus octane range is expensive . . .

in the light of either present or future importance of such factors as road rating and volatility.

Q. *Don't these various factors depend to a great extent on what automobile manufacturers will be doing for the next ten years in engine design?*

A. That's true and I feel a coordination of effort between the petroleum and automotive industries is of extreme importance at this time. Otherwise, refiners will be hard pressed to make a realistic decision if they are planning to modernize their plant facilities.

Q. *After a refiner has selected his process facilities and built his new plant, are most of his problems behind him?*

A. No, striking the optimum level of operation for all such facilities in a plant becomes a very complex problem. For example, when most catalytic reformers were initially installed, they operated at relatively mild severity, and further octane improvement could be achieved with relatively small incremental losses in yield. Under these conditions the cost of an incremental increase in octane expressed as cents per Research octane number barrel was frequently as cheap in the reformer as it would have been with the use of increased lead. However, with the increased severity demand from cat reformers today, it is generally advantageous to use rather high concentrations of lead.

The optimum combination of severity and lead concentration is . . .

The optimum combination of severity and lead concentration is something that would be peculiar to each refinery, depending on the particular processing facilities and the charge stocks available. Studies of this type should be made with regularity in order to take maximum advantage

Studies . . . should be made with regularity . . . to take maximum advantage . . .

of the facilities available in satisfying your market requirement at any given time.

What Ethyl Research offers you

Our Refinery Technology staff, backed up by the extensive facilities of the Ethyl Laboratories, will be glad to share their experience with your economics people when you conduct a cost analysis of your top octanes.

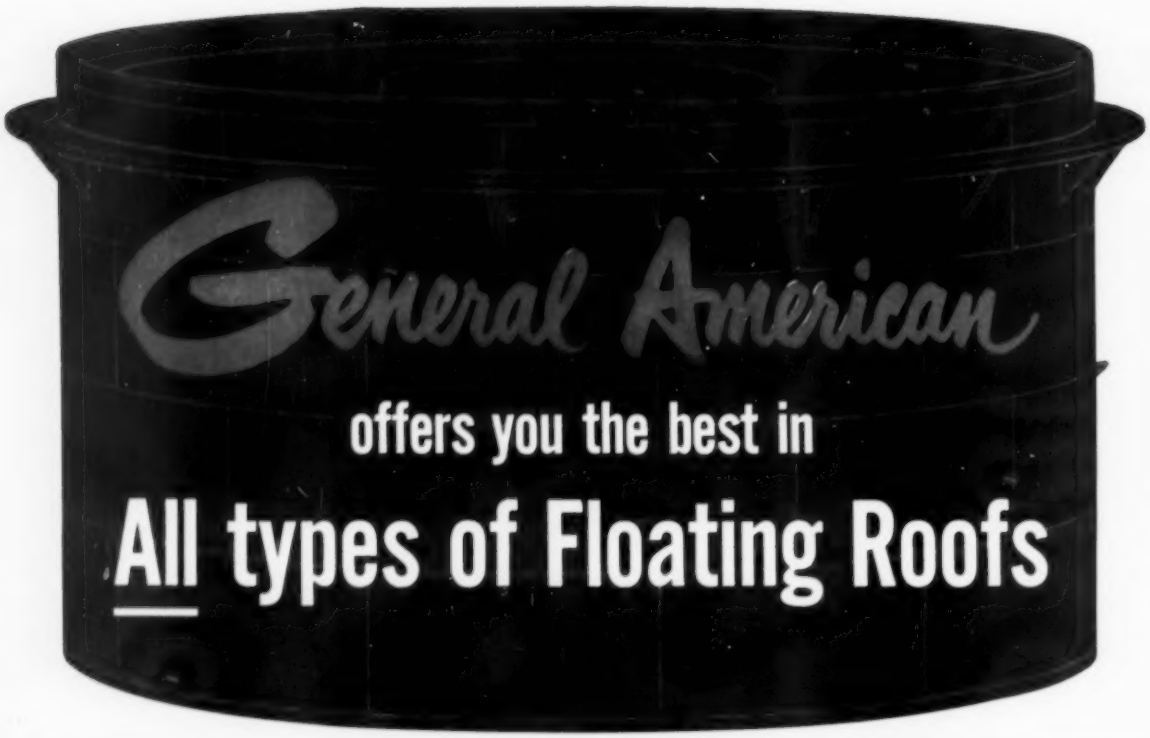
We will work with you, or if you prefer, we're even equipped to do a complete cost analysis for you.

We can help you answer these and other questions: When should you use "Ethyl" antiknock compound in preference to increasing the catalytic reformer charge rate? How does increased severity of reforming affect your costs? When should you carry your tetraethyllead content to the maximum allowable—and under what circumstances?

For the answers to these and other questions, send for your copy of our new publication "Common Cents per Research Octane Number Barrel." Address your request to Box 13, Ethyl Corporation, 100 Park Ave., New York 17, N. Y.

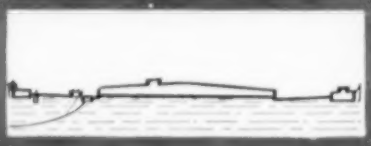
ETHYL CORPORATION
New York 17, N. Y.

Research Laboratories:
1600 W. Eight Mile Road, Ferndale 20, Mich.
2600 Cajon Road, San Bernardino, Calif.



WIGGINS HIDEK*

This is the natural design for storage of volatile products. A variable volume of vapor trapped beneath the steeply-pitched, quick-draining deck adds to its efficiency.



WIGGINS LODEK*

Designed so that the underside is in complete contact with the liquid surface. No vapor space can exist beneath the floating roof. Especially recommended where corrosive products are stored.

WIGGINS DOUBLEDEK*

If you prefer a double-deck roof choose the best—the new Wiggins Doubledek. Complete drainage design and between-deck accessibility add up to unmatched efficiency and safety.

WIGGINS FLOATING ROOFS PAY FOR THEMSELVES

Whatever your Floating Roof requirements get General American's UNBIASED analysis. Unbiased because General American makes ALL types of Floating Roofs!

Wiggins Floating Roofs, Dry Seal Gasholders, Lifter Roofs, Cone Roofs

*patented

WIGGINS VAPOR SEALS GENERAL AMERICAN TRADE MARK

GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South La Salle Street • Chicago 90, Illinois

Petroleum Processing

A McGRAW-HILL PUBLICATION

Editorial & Business Offices
330 West 42nd St., New York 36, N.Y.
Harry L. Waddell, *Publisher*

Editorial Staff

William F. Bland, Editor
William C. Uhl, Managing Editor
Virgil B. Guthrie, Associate Editor
Robert L. Davidson, Associate Editor
Willis A. Bussard, Assistant Editor
Alan Corneretto, Assistant Editor
William A. Caperell, Jr., Art Director
Stuart D. Boynton, Editorial Assistant
Anita Walter, Editorial Assistant
Ronald E. Cannon, Southwestern Editor
W724 Prudential Bldg., Houston 25
Richard R. Elwell, West Coast Editor
1125 West 6th St., Los Angeles 17
Andrew R. Patla, Washington Editor
1188 Nat'l. Press Bldg., Washington 4
Peter J. Gaylor, Patent Reviewer

Business Staff

K. W. McKinley, Advertising Sales Mgr.
R. H. Loyer, Business Mgr.
John E. Thompson, Production Mgr.
L. W. Nelson, Advertising Makeup
George Reid (Houston)
Assistant to the Publisher

Regional Sales Representatives

NEW YORK 36, N. Y.
Fred R. Emerson, 330 West 42nd St.
Walter W. Patten, 330 West 42nd St.

PHILADELPHIA 3, PA.
Fred R. Emerson, 17th and Sansom Sts.

ATLANTA , GA.
W. Kearns, 801 Rhodes-Haverty Bldg.

CLEVELAND 15, OHIO
William R. Freeman, 1510 Hanna Bldg.

CHICAGO 11, ILL.
Robert W. Bruley, 520 N. Michigan Ave.

HOUSTON 25, TEXAS
G. Jones, W724 Prudential Bldg.
Douglas C. Billian, W724 Prudential Bldg.

DALLAS 1, TEXAS
G. Jones, 1020, Adolphus Tower
Douglas C. Billian, 1020, Adolphus Tower

SAN FRANCISCO 4, CALIF.
T. Evans Wyckoff, 68 Post St.

LOS ANGELES 17, CALIF.
William C. Woolston, 1125 West 6th St.

ENGLAND, LONDON E.C. 4
Herbert Lagler, McGraw-Hill Co., Ltd.,
95 Farrington St.

Publisher's Page

Something Was Missing Last Month

DID you look carefully at your last issue of PETROLEUM PROCESSING? If you checked the spot where we usually run our fold-out "Clip-n-File" Process Data Sheet, you probably noticed that the page numbers jumped abruptly. They went without warning from 96 to 101. Those missing four pages had to be left out at the very last minute because we didn't have "PDS No. 6."

Actually, that's not quite correct. We did have a PDS; in fact, we had two—all written and ready to use.

We started to develop the first of them last December. When the data was received, however, we didn't think there was enough meat to justify publication. The process was described in generalities, rather than in the specifics we know you want and find helpful. Bob Davidson, our associate editor who handles PDS material, made a valiant effort at salvage and dug up more detail from other sources. But the licensor wouldn't approve the additions. He said they were out of date.

In the meantime, Bob got busy in January and built a fire under a second PDS—one which had been started earlier but was kept "simmering" because it wasn't scheduled until much later this year. He pulled that one up to the front burner and turned the gas on high to cook it fast.

That second one—after going through four revisions—was finally approved by the licensor, and sent to its parent company for a final blessing.

And then the last straw fell—the double-feature blizzard that hit New York on March 16 and 18. The one person with the parent company who had the last say was snowbound, and couldn't get into his office until the 21st. Our final, absolute, and oft-extended deadline had been noon on the 20th—and that afternoon we were reluctantly forced to admit defeat and yank out our April Process Data Sheet. By that time it was too late to cover up by changing page numbers—the rest of the issue was practically all printed.

Hence, the 4-page hole in April. That hole we respectfully dedicate as a memorial to better PDS's.

We really hope we don't have another hole like that in some future issue—but this I promise: If the material offered us isn't satisfactory, we'll have a hole rather than waste your time by running poor material just to fill space.

William F. Bland

—Editor

Other McGraw-Hill Petroleum Publications

National Petroleum News
The monthly magazine of oil marketing—news, prices, transportation, storage merchandising

Platt's Oilgram News Service
A daily independent oil-news reporting service issued from New York, Chicago, Houston

Platt's Oilgram Price Service
A daily independent oil-price reporting service issued from New York, Chicago, Houston

Petroleum Week
The industry-wide magazine—covering production, processing, transportation, marketing

it pays to plan with General American

SAFE, LEASED WAREHOUSES

Some liquids need to be "terminalled" in tanks of aluminum—some in stainless steel. Some must be kept warm with heating coils—some require refrigeration. Special valves and pumps must be designed to handle many of these liquids. Above all, you need the knowledge and experience of experts, especially for "ticklish" chemicals. General American has both facilities and personnel—available to you on an advantageous lease basis.

for your problem bulk liquids

"KEY MARKET" STORAGE—FOR OVER 50 LIQUIDS—NOW LEASED FROM GENERAL AMERICAN TANK TERMINALS

By maintaining liquid inventories at General American terminals, you can meet your own needs or fill orders quickly, efficiently and economically. You get the privacy, safety, service and flexibility of your own terminals *—without capital investment on your part.*

Six terminals at 5 key-market locations with over 500,000,000 gallons capacity: PORT OF NEW YORK (Carteret, N. J.) • PORT OF NEW ORLEANS (Good Hope, La.) • CHICAGO, ILLINOIS (Bedford Park) PORT OF HOUSTON (Galena Park and Pasadena, Texas) • CORPUS CHRISTI, TEXAS.

Two 630,000-gallon tanks hold industrial ethyl alcohol at Carteret terminal. 45 other tanks hold other liquids. Products are blended, drummed, weighed and prepared for shipping.

TANK STORAGE TERMINALS GENERAL AMERICAN

GENERAL AMERICAN TANK STORAGE TERMINALS

a division of GENERAL AMERICAN TRANSPORTATION CORPORATION

135 South La Salle Street • Chicago 90, Illinois

What's Happening...

in Refining

... **Pontiac Eastern Corp.'s** new $18-million refinery near Hattiesburg, Miss., will in effect be a "gasoline factory." It will charge 11,000 b/d of Mississippi crude and turn 70% of it into gasoline. Charge will be split between a Thermofor cat cracker and a Fluid coker, the coker gasoline being recycled to the TCC. An alkylation unit of 2500 b/d capacity is also planned. Construction, now underway by Fluor Corp., is scheduled for completion in April, 1957.

... **Continental Oil Co.** has awarded M. W. Kellogg Co. construction contract for an 11,000 b/d catalytic reformer at Ponca City, Okla., with completion to be mid-1957.

... **Gulf Oil Corp.** will build two 25,000 b/d "Gulfining" units at Port Arthur, Texas.

... **Shell Oil of Canada** is studying possibility of a new refinery at Edmonton or Calgary, Alta., but has made no further definite plans.

... **Lake Charles Chemical Co.** will construct a 10,000 b/d, $6,250,000 coking unit of undisclosed type at Lake Charles, La., to be operated by Continental Oil Co. as an integral part of its refinery. Expected production is 4200 b/d of liquids and 85,000 ton/yr of coke.

... **Suntide Refining Co.** will start building a new 15,000 b/d Rexforming unit at Corpus Christi, Tex., in July, and plans later to add a Udex unit for extraction of aromatics.

... **Indiana Farm Bureau Cooperative Association,** Inc. has awarded a construction contract to Southwestern Engineering Co. for $1,250,000 worth of new processing facilities at Mt. Vernon, Indiana. The installation will include a 3,000 b/d Platformer and a 2,100 b/d Unifiner with completion set for August.

... **Sun Oil Co.** has the following new refining facilities under consideration, according to its annual report: desulfurizing at Marcus Hook, alkylation at Toledo, catalytic reformers at both refineries (possible expansion of Toledo unit to produce aromatics), expansion of gas processing at Toledo, and additions to Houdriformer at Sarnia.

... **Commonwealth Oil Refining Co.** has begun a new project to expand its just-completed 23,000 b/d refinery in Puerto Rico to 55,000 b/d. Lummus Co. has the contract. Cost is estimated at $19.5-million, and new units will generally duplicate present units.

... **Atlantic Refining Co.** has announced an $11.5-million expansion program, with completion expected about mid-1957. Included are two 15,000 b/d Catformers, one at Philadelphia and the other at Port Arthur, Texas, Blaw Knox Co. has the construction contract.

... **California Oil Co.** has under way a $1-million project at Perth Amboy, N. J., to increase capacity of its 11,000 b/d Platformer by 25%. Primary engineering contractor is Bechtel Corp.

... **Sinclair Refining Co.** is building a new 7,500 b/d catalytic reformer at Wood River, Ill. with completion expected in the spring of 1957. The contractor is Arthur G. McKee and Co.

... **The Texas Co.** has obtained options on 770 acres for its proposed 30,000 b/d $50-million refinery at Anacortes, Wash. (See What's Happening, March, 1956, p. 9)

... **New construction projects** underway as indicated by recently approved fast tax write-offs:

- Cities Service Oil Co., $8,914,000 for a 2,060 b/d alkylation unit, residium cracker, and expansion of crude still, Ponca City, Okla.
- Bankline Oil Co., $608,000 for 3,000 b/d catalytic reformer, and $1,962,000 for 4,000 b/d Fluid coker, Bakersfield, Calif.
- American Gilsonite Co., $8,819,000 for plant to process gilsonite into 1500 b/d of gasoline and 300 ton/day of coke, Grand Junction, Colo.
- Shell Oil Co., $14,000,000 for 17,000 b/d Platformer, 17,000 b/d desulfurizer, 32,300 b/d prefractionator, and 15,300 b/d extraction unit, Wood River, Ill.
- Phillips Petroleum Co., $15,600,000 for distillation, cracking, alkylation, hydrogenation, and fractionation, Borger, Tex.; $6,289,000 for unit to isomerize a blend of n-hexane and methylcyclopentane for avgas components, Phillips, Tex.; $5,400,000 for 16,000 b/d catalytic reformer, Kansas City, Kans.; and $8,809,000 for feed preparation unit and expansion of alkylation unit, Sweeny, Tex.
- Standard Oil Co. (Ohio), $570,000 for expansion of catalytic cracking, Lima, Ohio.
- Republic Oil Co., $560,000 for conversion of thermal cracking unit and expansion of crude topping, and $175,000 for expansion of polymerization, Texas City, Tex.
- Standard Oil Co. (Indiana), $5,994,000 for 3800 b/d butylene alkylation unit, Sugar Creek, Mo.
- National Cooperative Refinery, $1,400,000 for 1450 b/d alkylation unit, McPherson, Kans.
- The Texas Co., $1,890,000 for expansion of crude still and catalytic cracking, Lawrenceville, Ill.; and $116,000 for a 25,000 b/d desalter at Port Arthur, Tex.
- Petrolite Corp., $73,120 for crude oil desalter at Gulf Refining Co., Port Arthur, Tex.; and $171,250 for a 130,000 b/d crude oil desalter at Tide Water Associated Oil Co., Delaware City, Del.
- Goliad Corp., $185,000 for a 1370 b/d butane

splitter at its natural gasoline plant in Live Oak County, Tex.; and $900,000 for expansion of its natural gasoline plant in Lavaca County, Tex.

in Petrochemicals

... **American Synthetic Rubber Corp.** will increase the capacity of its 44,000 ton/yr synthetic rubber plant at Louisville, Kentucky to approximately 68,000 ton/yr. Contract has been awarded to Walter Kidde Constructors, Inc. Completion is planned for first quarter of 1957.

... **Atlantic Refining Co.** plans to increase synthetic ammonia capacity at Philadelphia from present 100 to 175 ton/day.

... **Celanese Corp. of America** has announced plans to build a 40-million lb./yr polyethylene plant (Phillips' process) on a 220-acre site south of San Jacinto State Park near Houston. Completion is planned for early 1957.

... **Cosden Petroleum Corp.** has begun construction of a new $3-million, 20-million lb/yr styrene plant at Big Spring, Tex., with completion planned for Nov. Contractor is Badger Mfg. Co. Project is part of an $11-million expansion program Cosden has underway at the refinery. The styrene unit will use a recently developed "ultra-fractionation" process for recovering ethylbenzene directly from mixed xylenes.

... **M. W. Kellogg Co.** has purchased property in the Houston Ship Channel area as the site for a proposed plant of undisclosed size to produce new types of polyolefin plastics.

... **U. S. Industrial Chemicals Co.** has awarded a contract to Catalytic Construction Co. for the engineering and construction of a 10-million lb/yr isosebacic acid plant at Tuscola, Ill. Completion is scheduled for early 1957.

... **Spencer Chemical Co.** is adding new facilities at Henderson, Ky., for producing aqua ammonia and concentrated nitric acid. The aqua ammonia unit was scheduled for completion May 1: the acid unit for about the first of 1957.

... **Commercial Solvents Corp.** plans a $10-million expenditure this year to expand output of methanol and petrochemical derivatives.

in Transition

... **Standard Oil Co. (Indiana)** is developing a more streamlined organization for itself and its subsidiaries. Following changes are in planning stage and expected to become a reality by end of 1956:

Three chemical operations—Indoil Chemical Co., Pan American Chemicals Corp., and Hidalgo Chemical Co.—will form a single firm, probably with a new name. Pan-Am Southern Corp. will become part of American Oil Co. Stanolind Oil & Gas Co. will absorb Pan American Production Co., and American Pipeline Co. will be taken over by Service Pipeline Co.

... **Monsanto Chemical Co.** has made an agreement with L. Sonneborn Sons, Inc., under which Monsanto will market a new sulfuric acid-sludge decomposition process developed by Hunter Miley of Sonneborn.

Called the Miley-Monsanto-Sonneborn process, it converts the sludge into a gas of high SO_2 concentration (from which acid is recovered) and organic matter which is converted into coke.

... **Deep Rock Oil Co.** has purchased the 6500 b/d Cleveland, Okla., refinery formerly owned by Johnson Oil Refining Co., and plans to operate only the 1840 b/d catalytic reformer at Cleveland.

... **Belmas Co., Inc.** has purchased control of Waskom Natural Gas Corp. Waskom operates a plant near Shrevesport, La. which manufactures approximately 1,000 b/d of natural gasoline.

... **Sunset Oil** announced plans to merge with International Mining Corp., a San Antonio investment firm. Following expected stockholders approval in May, the merged company will be called Sunset-International Petroleum Corporation.

in Foreign Operations

... **in Britain and Europe:**

Compagnie Francaise de Raffinage (CFR) and Etablissment Kuhlmann will be partners with Societé des Usines Chimiques Rhone-Poulec of France in the construction and operation of a low-pressure polyethylene plant (Phillips process) near Gonfreville in Normandy. Ethylene will be supplied by local refineries of CFR.

Esso AG has put into operation its 6,000 b/d, $3-million hydrofining unit at Hamburg, Germany for the treating of diesel oil.

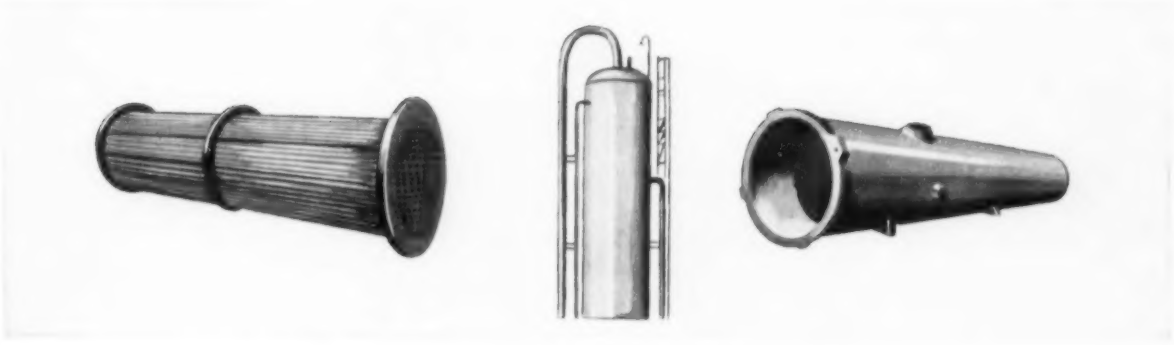
British Petroleum Co. Ltd. has awarded a $22.4-million contract covering the engineering of offsite facilities as part of its $72.8-million expansion program at Kent, England, jointly to Power-Gas Corp. and W. J. Fraser & Co. Ltd. The complete program at Kent will increase refinery capacity from its current 90,000 to 140,000 b/d, and includes construction of a new avgas plant.

West German Esso plans an investment of $125-million during the next three to four years, the major part of which will be devoted to a new refinery near Cologne, to go onstream in 1959 with a capacity of 60,000 b/d, and later to be boosted to 100,000 b/d by 1961.

Esso Petroleum Co. plans construction of a $25.2-million petrochemical facility at its Fawley, England,

YOU CAN STOP CORROSION

ALL AROUND THE REFINERY



WITH POLYRAD® INHIBITOR

Pine Chemicals Division

Naval Stores Department **HERCULES POWDER COMPANY** *984 King Street, Wilmington 99, Del.*

refinery, to produce butadiene, butylene, ethylene, and propylene, with completion scheduled for sometime in 1958.

Butadiene output will be fed to a 50,000 ton/yr. GR-S synthetic rubber plant to be built on an adjacent site by International Synthetic Rubber Co. (also to be completed in 1958).

Negotiations are now in progress between Esso and Monsanto Chemicals, indicating that Monsanto may build a high pressure polyethylene plant nearby. Monsanto has applied for permission to build such a plant at Fawley.

Caltex Petroleum Maatschappij (Nederland) N.V. is negotiating with Rotterdam for a lease to double acreage of its Pernis refinery. Land is wanted for plant additions and a new laboratory.

Société de Caoutchouc Butyl has been licensed by Esso Research & Engrg. to build a 20,000 ton/yr butyl rubber plant at Port Jerome, France, with completion planned for 1958.

. . . in Latin America:

Copebras (Companhia Petroquímica Brasiliera) will build a furnace-type, 30-million lb/yr carbon black plant near Santos, Brazil. A 10-year contract has been signed with Petrobras, the government-controlled oil company, for raw materials. Copebras is a Brazilian petrochemical firm whose owners include Celanese Corp. of America and Columbian Carbon Co. Latter firm will supply design, engineering, construction supervision, and continuous operating and technical services.

Brazil has refining expansion plans in the works at several locations. The Mataripe refinery will be raised from its present 5,000 to an ultimate 37,000 b/d. The Presidente Bernandes refinery will be expanded from its present 45,000 to 65,000 b/d. A new refinery has been planned with a capacity of 80,000 b/d in the Federal District.

Petroquímica S.A., a new company in Mexico, plans two $6-million plants financed by private U. S. and Mexican capital. Both will use fuel oil to produce anhydrous ammonia, and one will also make solid nitrogenous fertilizers.

The first, with 35,000 ton/yr ammonia capacity, is expected to be completed about mid-1958 at Guaymas, a northwestern coastal town, with raw materials being imported initially. Location studies are still under way for the second plant.

Meanwhile, an announcement is expected soon by Petroleos Mexicanos for a petrochemical plant at its Atzcapotzalco refinery at Mexico City.

Petroleos Mexicanos, plans an expenditure of $60-million beginning this year for three more catalytic cracking units. The units are scheduled for Tampico, Salamanca and Atzcapotzalco. It has also awarded a contract to Arthur G. McKee Co. for expansion of the Tampico plant from 78,000 to 100,000 b/d.

Pemex also is studying bids to build a 1000 b/d lubricants plant at Minatitlan, aiming at completion of the plant by the end of 1957.

Ecudorean government has signed a contract with Anglo-Ecuadorean Oilfields Ltd. for a new 6000 b/d refinery.

Esso Standard Oil S.A. has given contract to Arthur G. McKee Co. for $30-million project at Havana, Cuba, refinery, to boost capacity from 8500 to 35,000 b/d, and add Fluid cracking, cat polymerization, hydrofining, Powerforming, and related units.

Empresa Colombiana de Petroleos plans a $4-million expansion of propane recovery facilities at Barrancabermeja, Colombia.

. . . in the East:

British Petroleum Co. Ltd. is adding a new 8,000 b/d thermal reforming unit to its new refinery in Aden.

Sumitomo Chemical Co. of Tokyo is planning to start construction this summer of an 11-million lb/yr polyethylene plant in Ehime Prefecture, Japan. Arrangements have been made with Stone & Webster Co. for design and operation assistance. The $5,600,-000 plant will also produce 18,000 ton/yr of ammonia. Completion is expected by November, 1957.

Toyo Koatsu Industries, in cooperation with Teikoku Oil Co., will build a chemical plant in northwest Japan, to produce ammonia, urea and other ammonia products from natural gas.

in Markets and Prices

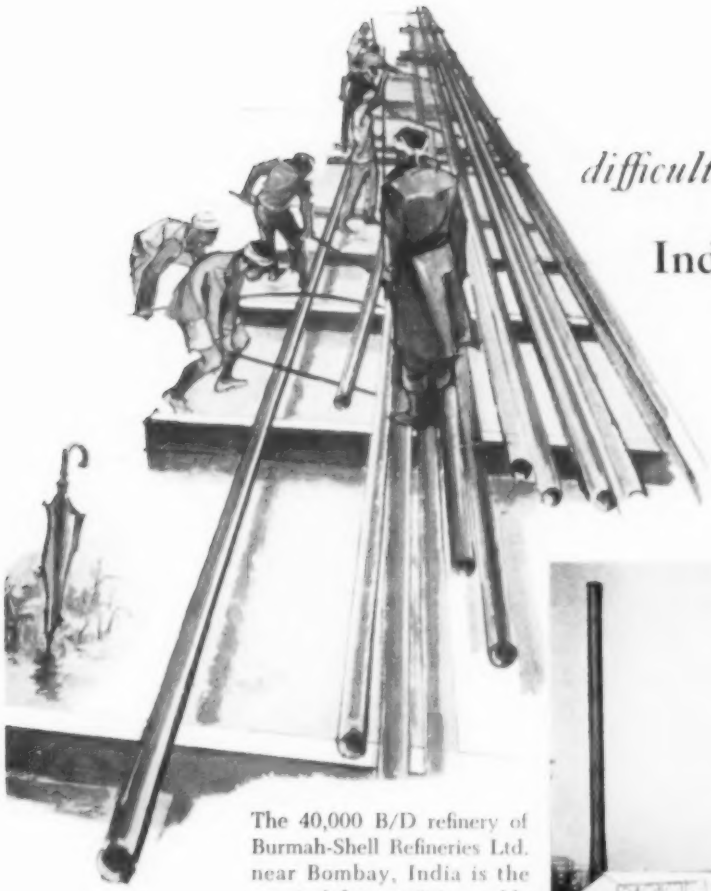
. . . Crude runs continued to decline and in early April were 576,000 b/d below the late winter peak of 8,-093,000. The trend was highlighted by announced cuts in crude runs by six majors that totaled 110,000 b/d.

. . . Products prices reacted seasonally in primary markets. On the Gulf, cargo prices for No. 2 dropped 0.25c/gal to 8.75c. Similar reductions were made in the Mid-Continent, with No. 2 quoted upward from 9c, Group 3. In the Midwest, wholesale price reductions also were made. On the Eastern Seaboard, however, prices generally held firm as a late cold snap pulled inventories down to the lowest level in years and created supply pinch problems.

. . . Gasoline inventories moved lower in early April for the first time since last October, but were still 7,000,000 bbl. above the recommended level of major companies reporting to the Texas Railroad Commission.

In addition to higher octane gasoline scheduled for the Great Lakes Pipe Line in April, a 98-octane premium and a 92-octane regular bowed in at the Gulf, priced at 13.375 and 11.625c/gal, respectively.

. . . Gasoline prices were increased 0.25¢/gal in the Midwest, with premium quoted at 14.25 and regular at 12.75c/gal. Natural gasoline prices went down another 0.5c/gal in the Mid-Continent. Grade 26-70 was quoted at 4.5c, Group 3, and 4c, Breckenridge. Lube oil prices in western Pennsylvania were advanced 0.5 to 1.5c/gal, following the 20c/bbl. hike in crude. Bright stock was 1c higher at 24c gal.



difficult physical conditions, but...

India's largest refinery was completed a year ahead of schedule

The 40,000 B/D refinery of Burmah-Shell Refineries Ltd. near Bombay, India is the country's largest. It is capable of supplying an estimated half of India's current requirements for finished petroleum. Although built in the face of difficult physical conditions, close cooperation with the owner in planning and engineering, and exceptional coordination of construction allowed Lummus to finish almost a year ahead of the original schedule.

A smoothly running refinery now, consisting primarily of crude distillation, fluid catalytic cracking, gas recovery, treating and blending units, offsite facilities and utilities, at the start it was only 450 acres of incredibly difficult terrain, without roads, railway or harbor.

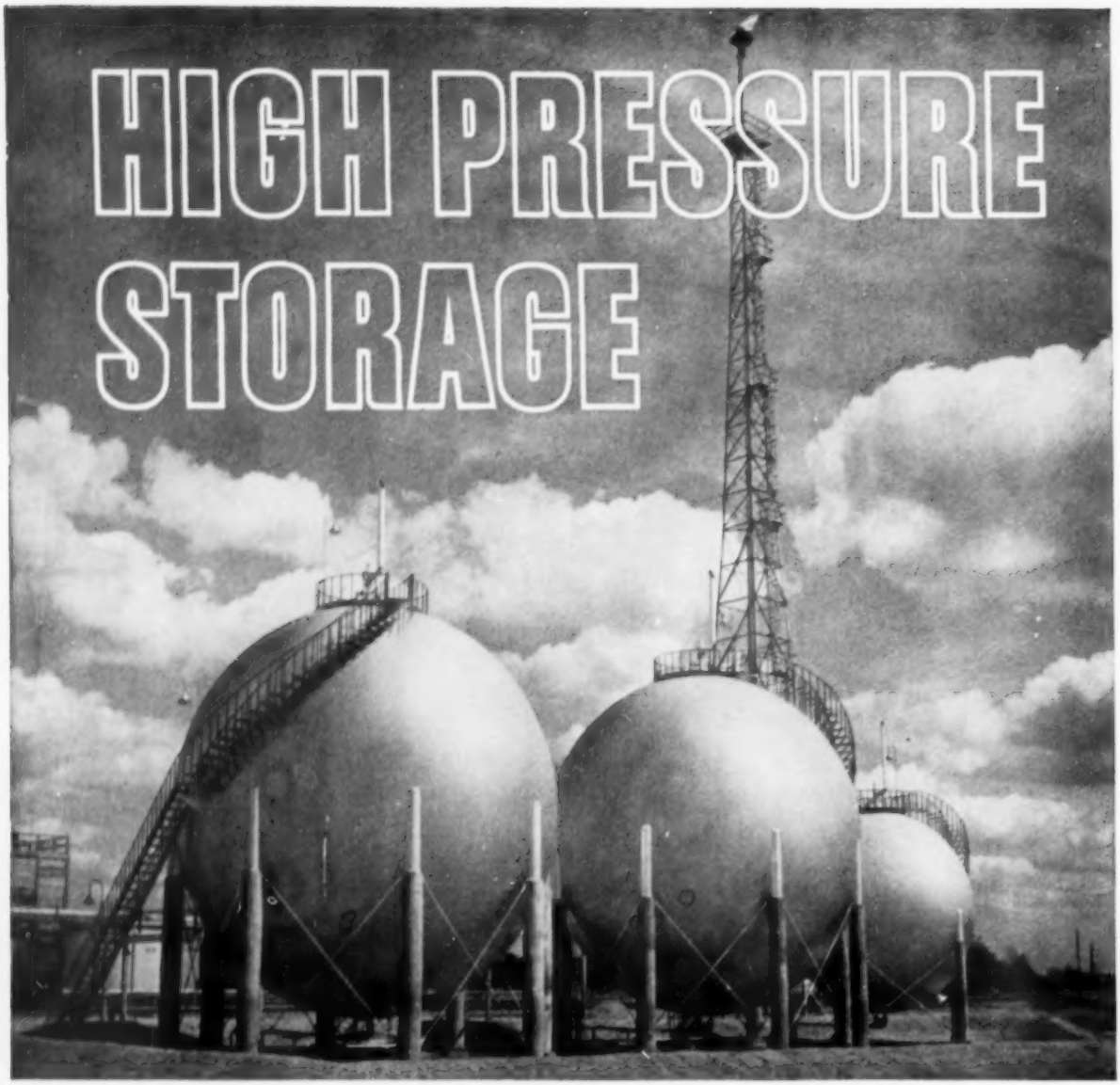
Battling two of Bombay's worst monsoons, Lummus employed as many as 14,000 Indians at peak periods. Terrain was filled and drained. Roads, rail lines, harbor facilities, and the complete refinery were constructed. The job was kept moving *ahead* of the timetable — and finished 21 months from the start of construction.

A project of this magnitude requires a worldwide organization of experienced engineers and construction men able to cope with any problem. Lummus is such an organization and can design and build your next plant whatever the size, type or location.

The Lummus Company, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pennsylvania. *Fabricated Piping Plant:* East Chicago, Indiana.

LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES



GRAVERSPHERES

solve gas and liquid storage problems

For pressure storage of process butane, iso-butane, natural gasoline and other volatile liquids and gases, Graverspheres are a "natural."

Graverspheres are formed in Graver shops and are first carefully assembled to insure accurate fit. After this they are shipped to location, erected and field-welded.

These spheres—the very shape of which is ideal for high-pressure storage in quantity—are available in capacities from 1,000 to 30,000 bbl. For gas storage Graverspheres are made to withstand pressures up to 100 p.s.i.g. and for liquid storage from 20 to 90 lb. water pressure.

As is the case with Graver tanks, towers and pressure vessels, traditional Graver quality and craftsmanship are inherent in Graverspheres.

GRAVER TANK & MFG. CO., INC.
EAST CHICAGO, INDIANA

CHICAGO • NEW YORK • PHILADELPHIA • EDGE MOOR, DEL.
CATASAUQUA, PA. • PITTSBURGH • CLEVELAND • DETROIT • TULSA
SAND SPRINGS, OKLA. • HOUSTON • ODESSA, TEXAS • CASPER, WYO.
LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

GRAVER builds tanks, towers and pressure vessels for the chemical and petroleum industries

Nuclear Fuel May Outbid Others In Remote Regions of the Earth

PETROLEUM still holds a strong position in its competition with atomic materials as a source of fuel. And most observers expect this situation to continue for some years to come.

In geographical areas far removed from normal and easy distribution of petroleum fuels, however, the use of nuclear energy may be much more imminent.

One concrete example is the probability that the radar warning line in Canada's far north may be powered by a portable atomic furnace. No explicit announcement to this effect has yet been made, but one observer has noted three events that could point in that direction:(1)

1—The Atomic Energy Commission some months ago awarded a contract for a reactor, none of whose parts will be too big to be carried in an airplane.

2—William J. Bennett, head of Atomic Energy of Canada, Ltd., Ottawa's equivalent of the AEC, stated recently that the Canadian government is considering designs of a small furnace especially suited to the conditions in the Arctic.

3—A United States-Canadian diplomatic agreement, signed in June, 1955, laid down specifications to govern what would happen if atomic power were to be used in connection with the radar warning network.

Although there is still a standing prohibition against exchange of information on U.S. military uses of atomic energy, the one exception to this prohibition has been made in connection with atoms in the Arctic. If atomic power is adopted for the radar line, and if the U.S. provides the furnaces, then it is agreed that detailed blueprints of such furnaces must be shared with Canada.

What this can mean for the future is tremendously significant—not only in the frozen north of Canada, but also any other remote regions of the earth. Economic development of the Far North has been slow because of a shortage of power. Even with oil available some 300 miles south of the Arctic regions, the problem of distribution has been great, depending on rivers—which are frozen most of the year—or on the remote possibility of pipelines being put through.

Canadian optimism about atomic fuel is well shown in a recent declaration by Mr. Bennett: "Bearing in mind our large supplies of uranium, we think there is a real future in the atomic fuel business. We think it makes good sense to aim at a situation where at least some of our uranium will be exported in the form of fuel elements."

That statement has been backed up by Canadian Trade Minister C. D. Howe's announcement in the House of Commons that Canada will be producing its own uranium metal within one year. Today, that country buys the metal from U.S. processors who make it from ore mined and refined in Canada.

It takes little more imagination to visualize other regions crying soon for economic development—other Arctic and Antarctic areas, distant jungle country in Artic and Antartic areas, distant jungle country in South America and Africa, Asia, Australia.

The last frontier is still a long, long way off.

—W.C.U.

(1) "Atoms in the Ice," by John E. Bird, Ottawa parliamentary correspondent, *Saturday Review*, March 24, 1956, p. 53.

Future Car Designs Can Create New Fuel Problem—Volatility

NOT higher octane requirements, but lower fuel volatility could well be the next big headache for refiners. Many present trends and possible future developments in automotive design are aimed at cutting down the octane sensitivity of the engine. These same developments could all magnify the problem of controlling fuel volatility.(1)

Here are some examples.

Fuel injection systems are fundamentally much more vapor critical than the carburetor, even with pressure supply systems, vapor bleed systems, and vapor separators.

Larger engines mean more rejected heat and more crowded engine compartments. This adds up to higher temperatures under the hood. At the same time, greater power lessens the detonation problem because of fewer wide-open-throttle accelerations.

Lower hood lines improve styling and visibility, but they mean crowded engine compartments and boost already high under-hood temperatures.

More accessories throughout the car also contribute to the rejected heat and to the crowding of the compartment under the hood. Air conditioning, power brakes, power steering, and larger generators are all desirable parts of todays' automobile. The car of tomorrow will have more. Some accessories, such as the automatic transmission, it is true, somewhat minimize the octane requirements. However, all of them add to the fuel volatility control problem.

These are but a few of the future design trends. The higher under-hood temperatures result in higher pressures for the same fuel volatility, with increased possibility of vapor-locking and hot-starting difficulties. These higher temperatures also increase octane requirements slightly because of the increased intake-air temperatures.

A high temperature is not nearly so critical to the octane number, however, as it is to the volatility of a fuel. This is because octane number is a factor only in a running engine and a moving vehicle, where flowing air minimizes high temperature problems.

Volatility problems, on the other hand, are most severe in a vehicle stopped after hard running. Then, the problems are magnified because there is no air to carry engine heat away—heat builds up and boils the fuel from the lines.

It seems likely then, that refiners may have a new

set of problems to add to the troublesome octane strain. Refiners are no novices in the field of fuel volatility, but they are going to be putting still more attention to techniques for controlling volatility than they have in the recent past. —R.E.C.

(1) "Are We Breeding a New Kind of Horsepower?" A. E. Cleveland, chief development engineer, engineering research dept., Ford Motor Co., presented at Western Petroleum Refiners Ass'n annual meeting, San Antonio, Texas, March 19-21, 1956.

Will Polypropylene Break Into the 'Big-Time' for Films and Fibers?

WHY the sudden interest among petrochemical manufacturers over polypropylene?

Add together solvent resistance, relatively high melting point (around 150°C., 302°F.), and a molecular weight over 100,000. Then couple these with low cost and available raw material. The result is a spreading interest in polypropylene.

Polypropylene is only one of many possible polymers that can be made by modifications of the two new 'low-pressure' polyethylene processes (Phillips and Ziegler), but it is the only one near to commercial production thus far. Polypropylene might be the next "big" plastic for film and fiber use, challenging other plastics such as its cousin, polyethylene.

Development of this polymer is going on in Italy, using know-how developed by Julio Natta at Milan's Polytechnic Institute, and working under a grant from Montecatini, the big Italian chemical development firm. Based on Carl Ziegler's ethylene polymerization work, the low pressure, low temperature, Natta-developed process is reported licensed by Montecatini through agreements with Ziegler. Natta's technique is said to apply to other polymers also, such as polystyrene.

Other Ziegler process licensees around the world are working on propylene polymerization, and the German mining firm, Hibernia, is running a one ton/day pilot plant.

Phillips' low-pressure polyethylene process is also reported capable of making the polypropylene with molecular weights above 50,000—even higher after modifying the basic Phillips chrome oxide-catalyzed polyethylene process.

A copolymer of ethylene and propylene is being studied by Phillips; and interestingly enough, M. W. Kellogg (fourth Phillips polyethylene process licencee) mentions the possibility of "a whole new spectrum of resins from olefins."

The fly in the ointment is polypropylene's alleged susceptibility to oxidation and yellowing. But, it's safe to predict that processors will not be so easily stopped, and a new stabilizing inhibitor will undoubtedly be found to help polypropylene realize its exciting potential. In fact much of today's experimentation aims at developing an inhibitor which will make polypropylene more stable. —R.L.D.

Sharp, H. T., "Getting Set for Polypropylene Rush," *Chemical Engineering*, March, 1956, pp. 103-4.

New Petrochemical Opportunities Sky-Wide in the Missiles Field

THAT the petrochemical industry will play an increasingly important role in supplying the missiles field has been emphasized by a recent summary.[1]

Market-wise, it will be big business. Even under "cold war" conditions, estimates are that the United States in 1957 will spend $30-million for missile propellents, $40-million for research & development of propellents, and $50-million for research and for procurement of lubricants, hydraulic fluids, etc.

What kinds of materials are sought for propellents? The list includes: ammonia, alcohols, hydrazines, JP fuels, ethylene oxide, oxygen, hydrogen peroxide, gasoline, acetylenes, polysulfide rubbers, unsaturated polyesters, butadiene vinyl pyridine polymers, ammonium nitrate, plastics, kerosine, among others.

And what about lubricants? These include silicone-base oils, fluorocarbon oils, heterocyclic hydrocarbon oils, and mineral oils.

These then, are the types of materials aimed at.

What are the ideal properties? In general, these can be broken down into three classes of materials: liquid propellents, solid propellents, and lubricants.

The ideal liquid propellent has to pass 13 tests: 1) high energy, 2) boiling pt. above 90°C., 3) freezing pt. below —60°C., 4) high viscosity index, 5) density no greater than 0.9 gm/cc., 6) no toxic effect, 7) noncorrosiveness to standard materials of construction, 8) low cost, 9) ease of ignition with common oxidizers or fuels, 10) insensitiveness to mechanical and thermal shock, 11) low vapor pressure, 12) suitability as regenerative coolant, and 13) nonluminous exhaust.

There are five keys to a good solid propellent:

1) High tensile strength to prevent deformation under pressure and acceleration.

2) High percent elongation to counteract deformation under pressure.

3) Good adhesion, so charge can follow expansions and contractions in the motor chamber without breaking the bond in bonded rocket motors.

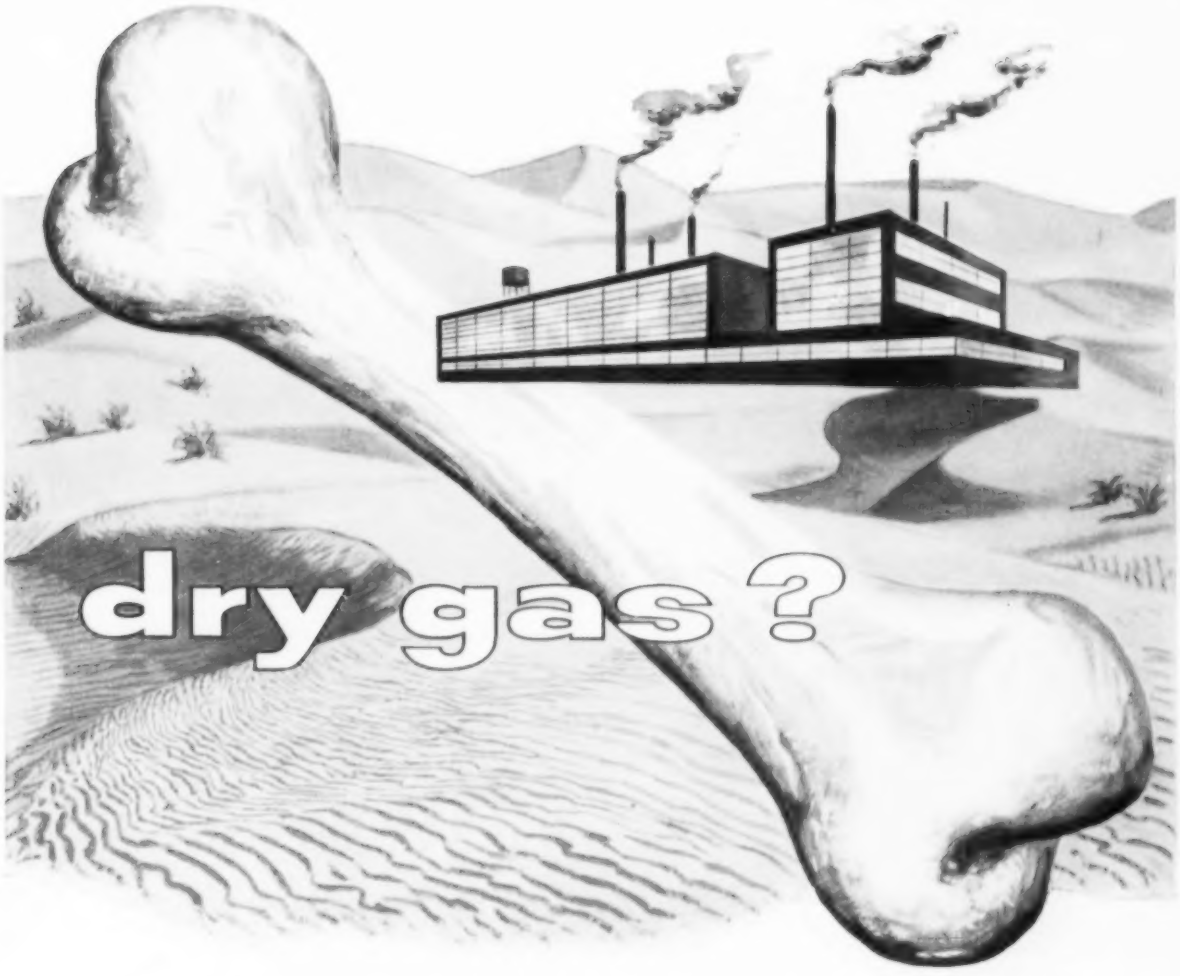
4) High initial fluidity in the case of cast propellents so mixture can be poured into rocket motor case.

5) Controllable burning rate, a function of particle size and pressure.

The ideal lubricant must have: 1) good lubricity under heavy shear and over a wide temperature range, 2) thermal stability at boiling pt., 3) viscosity of 1 centistoke at 700°F. and less than 2500 centistoke at 0°F., 4) resistance to oxidation and deterioration by highly corrosive missile fuels, 5) hydrolytic stability, 6) noncorrosiveness to standard materials of construction, 7) incombustability, 8) ease of handling, 9) low cost, and 10) no toxicity.

The immediate future undoubtedly will bring greater emphasis on research to find materials meeting the above requirements. The long-term future could well be fantastically big. Missile technologists dream of passenger-carrying, rocket-powered missiles, whose fuel demands could expand 10 times over today.

(1) "The Sky's the Limit," *Chemical Week*, April 7, p. 61.

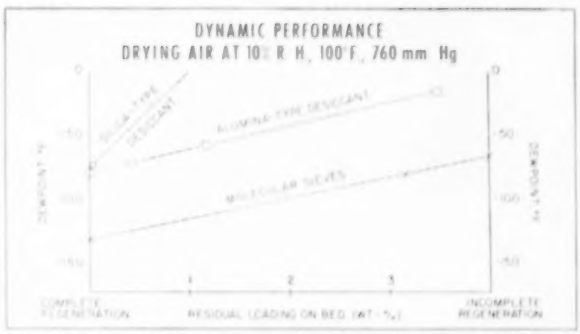


Now you can dry gases drier than dry!

LINDE Molecular Sieves can dry your gases—air, hydrogen, chemical streams—more thoroughly than any other commercial adsorbent. They will duplicate laboratory performances—*in your plant*—under normal *production* conditions.

Even though your gas stream may already be partly dried, Molecular Sieves will remove the last traces of moisture. Only a small volume of adsorbent is required. The same combination of high capacity and low dew-point is also obtained at high temperatures, up to 200° F.

This is SUPER-drying! Dynamic performance is shown in the accompanying graph. This superior performance also can be expected at higher relative humidities and at other temperatures and pressures. Of particular significance in production is the relative insensitivity of Molecular Sieves to incomplete regeneration.



For further information, write for data sheets on "Drying of Gases." Address Dept. **PE-5**, Linde Air Products Company, A Division of Union Carbide and Carbon Corporation, 30 East 42nd St., New York 17, N. Y.

Linde
TRADE MARK
MOLECULAR SIEVES

The term "LINDE" is a registered trade mark of Union Carbide and Carbon Corp.

FIRST OF THE 1500 SERIES

The 1575 is a force-balance transmitter for converting from differential pressure to a 3-15 psig signal. Provides accurate instantaneous transmission of flow rate.

1575 TRANSMITTER

- Wide range 0-20 to 0-200 inches of water differential.
- Adjustable hydraulic damping.
- All working parts sealed from process fluid.
- External screw driver zero adjustment.
- Temperature compensated to 300° F.
- Steam traced flanges available.
- Quickly removable without disturbing piping.

Write for complete information. Ask for catalog 50-30.

FP FISCHER & PORTER CO.

LA 1085 COUNTY LINE ROAD, HATBORO, PA.

(To obtain more data on advertised products see page 174)

Letters

Pressure Vessels

To the Editor: When my 4-part article on "Keep Those Pressure Vessels Safe" was published in Petroleum Processing (April, pp. 502-4; May, pp. 666-8; June, pp. 949-53; and July, pp. 989-91), Figs. 1 and 2 for the third part of the article appearing in the June issue were taken from the draft of a proposed API Recommended Practice bulletin on pressure relieving systems. At the time, a firm decision to publish this bulletin had not been made, so no credit could be given to it in my article.

In January of this year, the bulletin was published under the designation "API RP 520, 1st ed., Sept. 1955—Recommended Practice for the Design and Construction of Pressure-Relieving Systems in Refineries (Tentative) 1955" and is available through the New York office of the American Petroleum Institute, 50 West 50th St., at $1.50 per copy.

I would appreciate it if you would inform your readers as to the source of these illustrations which were prepared by Dr. L. W. T. Cummings of Sun Oil Co.

Walter Samans
Philadelphia, Pa.

PDS Suggestions

To The Editor: We are taking this opportunity to follow up your suggestion in the November issue of Petroleum Processing and commenting on your new make-it-yourself process handbook.

Your Process Data Sheet shows only one pump. We realize, of course, that this may be perfectly true; however, it would be a little unusual in the petroleum or petrochemical field, and since we are not very familiar with this particular process, it is of great interest to us. In this regard, we are wondering if it might be possible in either or both the process write-up, as well as in the diagram, that there might be more indication of the various gas, vapor, and liquid phases of the process. Also, in the case of liquids particularly, could there be more indication of where pumping equipment is involved.

It also occurs to us that this whole ambitious program of yours might become easier for you and extremely more valuable and convenient for the users if a legend sheet were pub-

lished for inclusion in the front of the process data book. This legend sheet could, of course, be revised from time to time to include new symbols which may be required with the development of new processes and necessary equipment.

In conclusion, may we offer our compliments for this very worthwhile venture which you are undertaking.

H. E. MICHENER, JR.
The Garlock Packing Company
Mechanical Seal Department
Palmyra, New Jersey

● *Mr. Michener's suggestions are well-taken. There are more pumps in the Ethylene Oxide process system than indicated in our flow chart. However, since many pumping alternatives are usually possible in any given process, we have had to limit our flow charts to show only those which give a major change in process stream pressure levels. To include every pump would then lead to many other items—control valves, manifolds, bypasses, etc.—and soon we would no longer have a "simplified" process sheet.*

However, we will try to insure that all future sheets have as much of the above information as is practical, and we are working on the suggested legend sheet.

Any more suggestions or ideas?

Wrong Drawing

TO THE EDITOR: We have noted an error in the March, 1956, issue. The article on Canadian Petrofina's Montreal refinery, p. 77, lists a Platformer unit. The catalytic reforming unit at this refinery is an Ultraformer, not a Platformer. It is listed correctly in the table on p. 75 in the same story in March.

E. L. d'OUVILLE
Senior Technologist
Development & Patent Dept.
Standard Oil Co. (Indiana)
Chicago 80, Ill.

● *Thank you, careful reader d'Ouville. This one whizzed past three otherwise careful proofreaders on our staff, as well as most readers, apparently. The trouble was transposed illustrations. The correct drawing, showing an Ultraformer in the listing, was on p. 80; the drawing on p. 77 should have been on p. 80.*

For Every Corrosive Service

"JOHN CRANE" FreeFlow Construction
Gasket flush with pipe I.D. — allows completely unrestricted flow. No air pocket — insert flush with I.D. of envelope. No danger of rupture due to expansion of entrapped air at high temperatures.
Ordinary "Wishbone" Construction
Envelope extends beyond I.D. of pipe, causing flow restriction and turbulence.
Expansion of entrapped air at high temperatures presents danger of gasket rupture.

JOHN CRANE

FreeFlow
GASKETS made of TEFLON*

"John Crane's" FreeFlow construction and chemically inert Teflon have been combined as *the* answer for gaskets in corrosive service. This new construction assures a flush fitting with the I.D. of the pipe and the inner wall of the Teflon envelope, not possible with the ordinary "wishbone" type gasket. (See drawing above).

This means elimination of:

1. Flow restriction and turbulence in the line.
2. Danger of rupture at high temperature due to entrapped air between gasket insert and Teflon envelope.

"John Crane" Teflon FreeFlow gaskets are impervious to practically every known chemical or gas and are unaffected by temperatures from −100° to +482°F., depending on the insert material. They are available in all shapes and sizes for a wide variety of applications, such as glass lined, porcelain, pyrex and similar equipment, including reactor kettles and pipes, distillation columns and nozzles.

Request full information on "John Crane" FreeFlow gaskets for your particular requirement. Ask for our informative booklet, *The Best in Teflon*, for other important technical and application data. Crane Packing Company, 6432 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., Hamilton, Ont.

*DuPont trademark

JOHN CRANE CRANE PACKING COMPANY 38 YEARS INDUSTRIAL PROGRESS

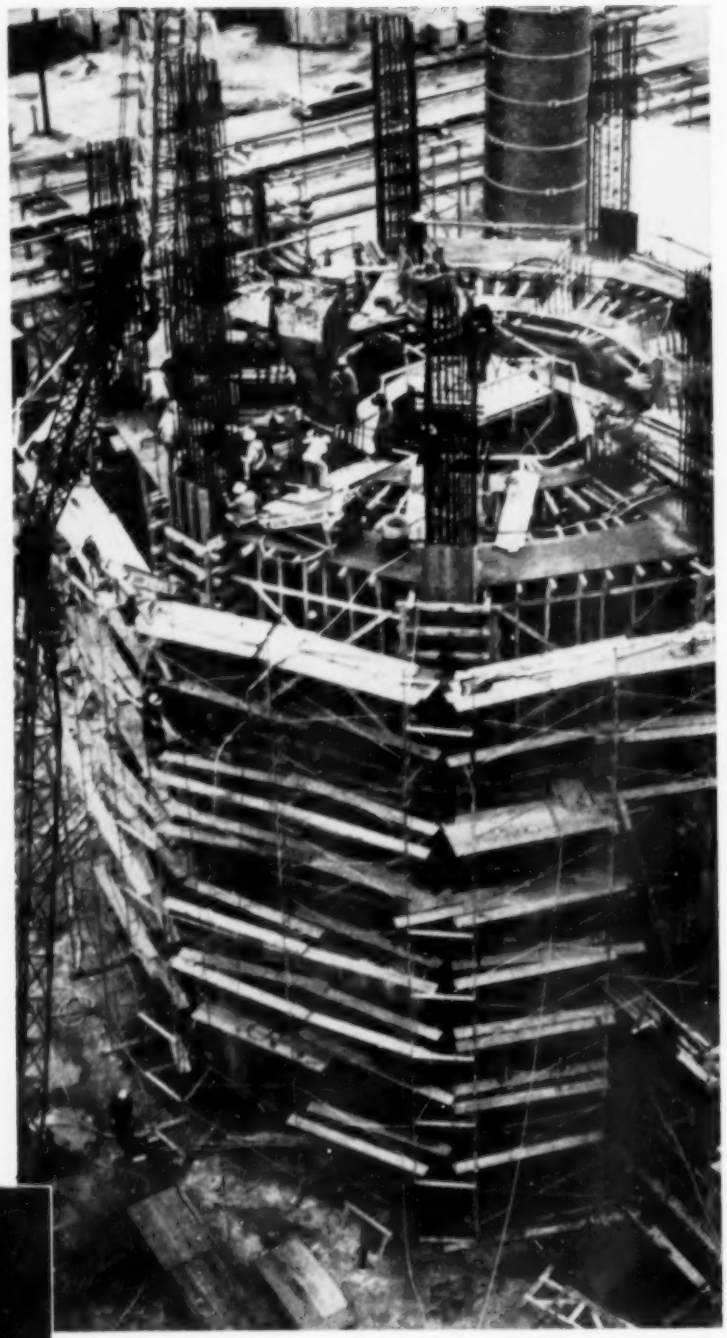
(To obtain more data on advertised products see page 174)

Going UP!

World's Largest Airlift TCC Unit is now being built at Beaumont, Texas. This 35,000-Barrels-A-Day Unit is one of 50 Airlift TCCs built or building all over the world.

Part of New York's skyline—TCC Unit at Socony Mobil's Brooklyn refinery.

West Germany—TCC Unit at Heide Refinery of Deutsche Erdol-A.G.



TCCs are operating on all six continents—from Finland to Formosa, from Australia to Turkey

The Airlift Thermofor Catalytic Cracker is licensed by:

SOCONY MOBIL OIL COMPANY, INC.

26 Broadway, New York 4, N. Y.

Bingham

"KOKE-KRUSHER" HOT OIL PUMP

NON-CLOGGING!

PULVERIZES LARGE PIECES OF ENTRAINED COKE IN PUMPAGE

Bingham Type CKM
"Double Volute", Two Stage,
"KOKE-KRUSHER" for handling
hot, coke-laden pumpage at high heads.

CRUSHES COKE INSTANTLY
Positive crushing mechanism instantly crushes large pieces of hard coke entrained with the pumpage.

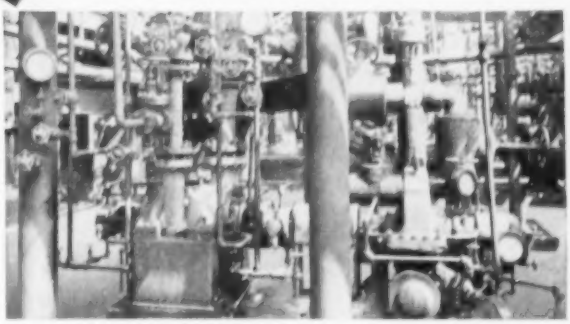
- Results in more hours on stream—less down time.
- The pulverizing action on entrained solids reduces clogging of other system equipment.
- Non-pulsating flow eliminates need of auxiliary equipment for control of pressure and/or capacity.
- Eliminates expensive protective devices.
- Smooth pump characteristics eliminate destructive vibration.
- Lower maintenance. Only one moving part.

HANDLES COKE-LADEN HOT OIL IN CRACKING SYSTEMS WITHOUT CLOGGING

The Bingham "Koke-Krusher", the only pump that crushes coke, is a field-proven, centrifugal pump specially designed for the severe services of pumping oil products such as *Residuum, Flash Tower Bottoms, Black Oil Recycle*—in which the oil carries in suspension pieces of hard coke of irregular size and shape.

This revolutionary Bingham pump features a coke crushing mechanism located in the suction chamber immediately in front of the impeller eye. Any piece of solid coke entrained in the pumpage *must* pass through the crusher, where it is instantly pulverized, before entering the impeller.

The resulting pulverized coke particles are small enough to assure free flow through the pump and all system equipment. The Bingham "Koke-Krusher" will make a big difference in your operations. Call your nearest Bingham office for full details.



Bingham "Koke-Krusher" pumping flash tar bottoms in pressure coke still of a large midwest refinery.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

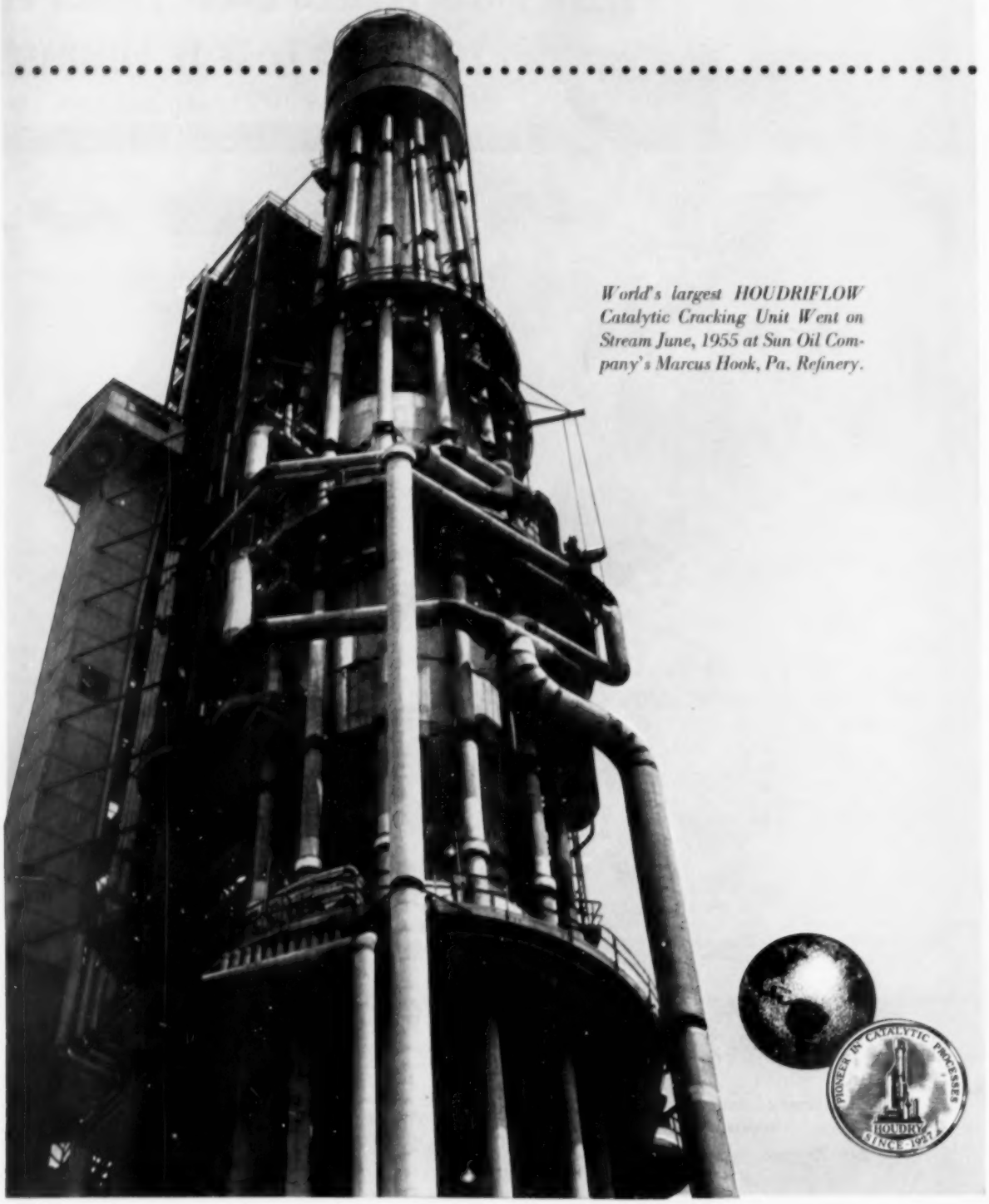
General Offices: **2800 N.W. Front Avenue, Portland 10, Oregon**

Factories: **Portland, Ore. • Vancouver, B.C., Canada**

SALES AND SERVICE OFFICES

BOSTON, MASS.	NEW YORK CITY, N.Y.
CHICAGO, ILL.	PHILADELPHIA, PA.
CLEVELAND, OHIO	PITTSBURGH, PA.
DALLAS, TEXAS	SAN FRANCISCO, CALIF.
DENVER, COLO.	SEATTLE, WASH.
HOUSTON, TEXAS	ST. LOUIS, MO.
KANSAS CITY, MO.	ST. PAUL, MINN.
LOS ANGELES, CALIF.	TULSA, OKLA.
NEW ORLEANS, LA.	TORONTO, ONT., CAN.
VANCOUVER, B. C., CAN.	

Discover for yourself...the inherent



World's largest HOUDRIFLOW Catalytic Cracking Unit Went on Stream June, 1955 at Sun Oil Company's Marcus Hook, Pa. Refinery.

economies of Houdry Processes

20 YEARS AGO—after 13 years of fundamental research—Houdry Process Corporation pioneered the first commercially practicable catalytic cracking unit, as well as the first natural and synthetic cracking catalysts. This resulted in important and far-reaching changes in the petroleum processing industry. Since that time, through continuous research and extensive commercial experience, Houdry has developed other processes and catalysts that offer refiners many inherent economies and better products.

Research, Engineering and Technical Services

Houdry scientists carry on a continuous program of research related to catalysis, processing and equipment. Houdry engineers assist refiners in the planning, operating, maintenance and profitable exploitation of their processing facilities. Subsequent service to licensees may include continuing plant surveys, application of design studies, direct assistance with operating problems and studies of changes in processing schemes required to meet changing crudes and products.

Catalyst Manufacturing and Marketing

The Chemicals Division of Houdry manufactures synthetic silica-alumina catalysts and a line of extremely hard alumina base catalysts, plus other special types. In 1956, a new pelleted kaolin cracking catalyst was introduced for marketing. Houdry's long experience in catalysis permits integration of catalyst performance with specific application requirements. The Chemicals Division also produces pelleted type catalysts to specification, and develops catalysts for special needs.

HOUDRIFLOW Catalytic Cracking Process for the highest product yields at lowest costs

The HOUDRIFLOW Process is outstanding for its high yields of gasoline and high liquid recoveries with accompanying low coke and low dry gas yields. HOUDRIFLOW's simplified design affords flexibility in the choice of operating conditions and types of charging stocks to be processed. The integration of the reactor and kiln into a single vessel makes it necessary to lift the catalyst only once and requires a smaller ground area for the installation of a unit of a given capacity.

HOUDRESID Catalytic Cracking Process for catalytically cracking the bottom of the petroleum barrel

The HOUDRESID Process eliminates the production of heavy residual fuel by making it practical and economical to catalytically crack the bottom of the petroleum barrel. This refinery-proved, continuous moving bed process converts reduced crudes into exceptional yields of high-octane gasoline and light distillate fuel. The process is well adapted to the use of synthetic or natural clay catalyst, and to the charging of a wide range of reduced crudes.

HOUDRIFORMING Catalytic Reforming Process for maximum yields of aromatics or highest octane fuel

The HOUDRIFORMING Process assures maximum yields of high octane fuel and aromatic concentrates from straight-run naphthas. By utilizing a dual-function catalyst, HOUDRIFORMING provides complete flexibility for producing aromatics or motor gasoline. The process is continuous and non-regenerative. However, for flexibility of operation the catalyst can be regenerated *in place*.

HOUDRY ISO-PLUS Catalytic Reforming Process for reforming low-octane naphthas into 100-octane gasoline

The HOUDRY ISO-PLUS Process reforms run-of-the-refinery, low-octane naphthas into gasolines with octane ratings in excess of F-1 clear. Variations of the ISO-PLUS Process yield from 86% to 91% of naphtha charge stock into 100-octane gasoline.

HOUDRY DEHYDROGENATION Process for single-step production of butadiene from normal butane

The HOUDRY DEHYDROGENATION Process is the only commercially-proved, single-step process for the production of either butylenes or butadiene from low cost butane. This process is also applicable to the production of propene from propane and isobutene from isobutane.

For further information on Houdry processes, services or catalysts, write to Houdry Process Corporation, 1528 Walnut St., Philadelphia 2, Pa.

HOUDRY
PROCESS CORPORATION
PIONEER IN CATALYTIC PROCESSES

(To obtain more data on advertised products see page 174)

The Foxboro M/58 Consotrol Controller (shown full size, without cover). Can be panel-mounted on Consotrol Control Station, or field-mounted.

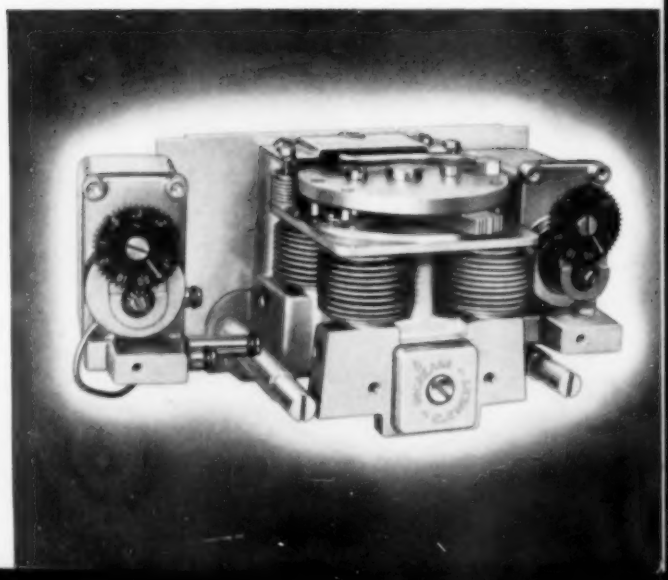
THE FOXBORO M/58 CONSOTROL

The M/58 Controller's Revolutionary Floating Disc System

Here's the exclusive Foxboro design development that gives M/58 Control its unique versatility, precision, and stability. The floating disc and matched bellows assure uniformly high controller sensitivity and pin-point control action, even at widest settings of the proportional band. Lever-set proportional band adjustment is calibrated to 500%.

Component Construction Gives Unrivaled Versatility

Not only is the complete controller easily detachable as a unit, but also, each component is a "plug-in" unit. For example, reset plugs in at right as shown; derivative, similarly, at left. All 4 control actions, with 2 reset ranges, are available and easily adjustable to widest variations in operating conditions. Proportional action from 1 to 500% quickly set by lever.



Outperforms all other controllers!

...the controller with the FLOATING DISC

If you think this claim is exaggerated, just put a Foxboro M/58 Consotrol* Controller on your process. The tougher the job, the more it will outperform other controllers! Or ask any present user . . . many of the largest, most progressive petroleum and chemical processors are using hundreds of these instruments. They will unhesitatingly confirm that this exclusive Foxboro development has put their processes "on stream", automatically and smoothly from the control room, without false starts or confusion.

The M/58 Controller can do the same for your process. The flexibility of its control functions makes it readily adaptable to *all* processing techniques. All four actions are available, with two ranges of reset . . . all are easily adjustable to the most widely varying operating conditions. For example, reset and derivative functions plug in . . . proportional action from 1 to 500% can be quickly set by a lever. And calibration is a simple zero adjustment!

Get full details on this simple, truly "universal" Controller. Write for Bulletin 13-19 and ask your Foxboro Sales Engineer for a demonstration. **The Foxboro Company, 915 Neponset Ave., Foxboro, Mass., U.S.A.**

*Reg. U.S. Pat. Off.

FOXBORO CONSOTROL INSTRUMENTS

Reg. U.S. Pat. Off.

ROCKWELL-

Often Copied...

40th YEAR *of*

(To obtain more data on advertised products see page 174)

Nordstrom VALVES

Never Equaled

Rockwell-Nordstrom is the *original* lubricated plug valve. But that is only part of the story behind forty years of lubricated plug valve leadership. Starting with the first valve, *every major development* in lubricated plug valves has come to you *first* in a Rockwell-Nordstrom valve. Today, as always, the *oldest* lubricated plug valve is also the *newest* in terms of better performance, longer life and lower cost.

Below are listed only a few of the more than ninety basic Rockwell-Nordstrom valve and lubricant innovations. They are the reasons why Rockwell-Nordstrom valves—although often copied—have *never* been equaled. Rockwell Manufacturing Company, Pittsburgh 8, Pa.

Canadian Valve Licensee: Peacock Brothers Limited

ROCKWELL-Nordstrom VALVES

Lubricant Sealed for Positive Shut-off

first... for forty years *Here are just a few of more than ninety basic valve and lubricant innovations that have maintained the leadership of Rockwell-Nordstrom valves—through better performance, longer life and lower cost.*

- **FIRST Lubricated Plug Valve**
- **FIRST Sealdport* pressurized lubricant sealing**
- **FIRST Hydraulic plug jacking for fast, dependable operation**
- **FIRST Hypreseal* for high pressure plug valve service (still exclusive)**
- **FIRST Special plug and body coatings—longer life on "tough" services**
- **FIRST Automatic shut-off valves for gas pipelines**
- **FIRST "Self-Energizing" valve lubricants**
- **FIRST Line of special and general purpose valve lubricants**
- **FIRST Multiport lubricated plug valves for 3-way and 4-way flow control**
- **FIRST Lubricated plug valve for low temperature service**
- **FIRST Venturi valve for lower cost on larger lines**
- **FIRST Lubricated plug Christmas tree valves**

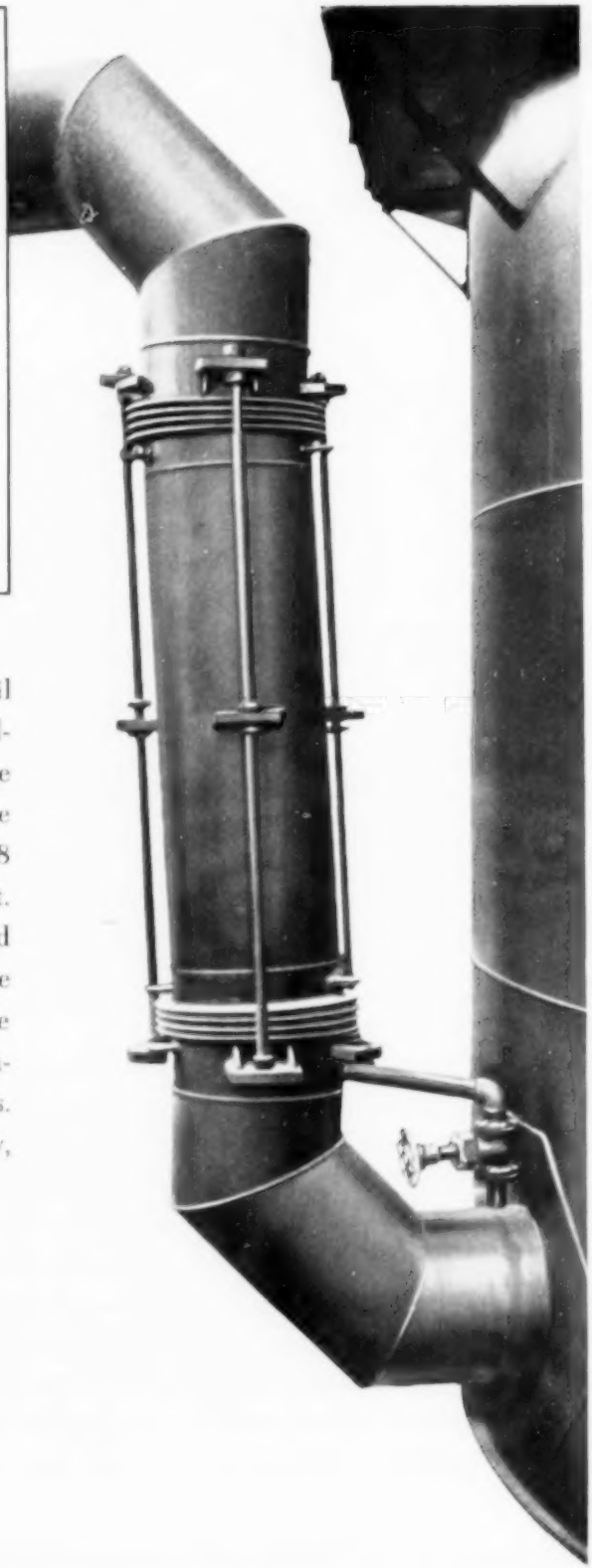
*Registered trade mark Rockwell Manufacturing Company

lubricated plug valve leadership

(To obtain more data on advertised products see page 174)

SOLA-FLEX®

expansion joints for Standard of California



AT THE EL SEGUNDO REFINERY of Standard Oil Company of California, this Sola-Flex bellows assembly does a big job. It absorbs the movement of a 228 foot overhead line. The double-end tied-joint takes a total of 10.88 inches of thermal growth by offset movement. And the end thrust of the bellows caused by internal pressure is not imposed on the piping system. All major oil companies use Sola-Flex expansion joints. Send for a catalog describing standard and special designs. Write Dept. C-11, Solar Aircraft Company, San Diego 12, Calif.

SOLAR
AIRCRAFT COMPANY
SAN DIEGO DES MOINES

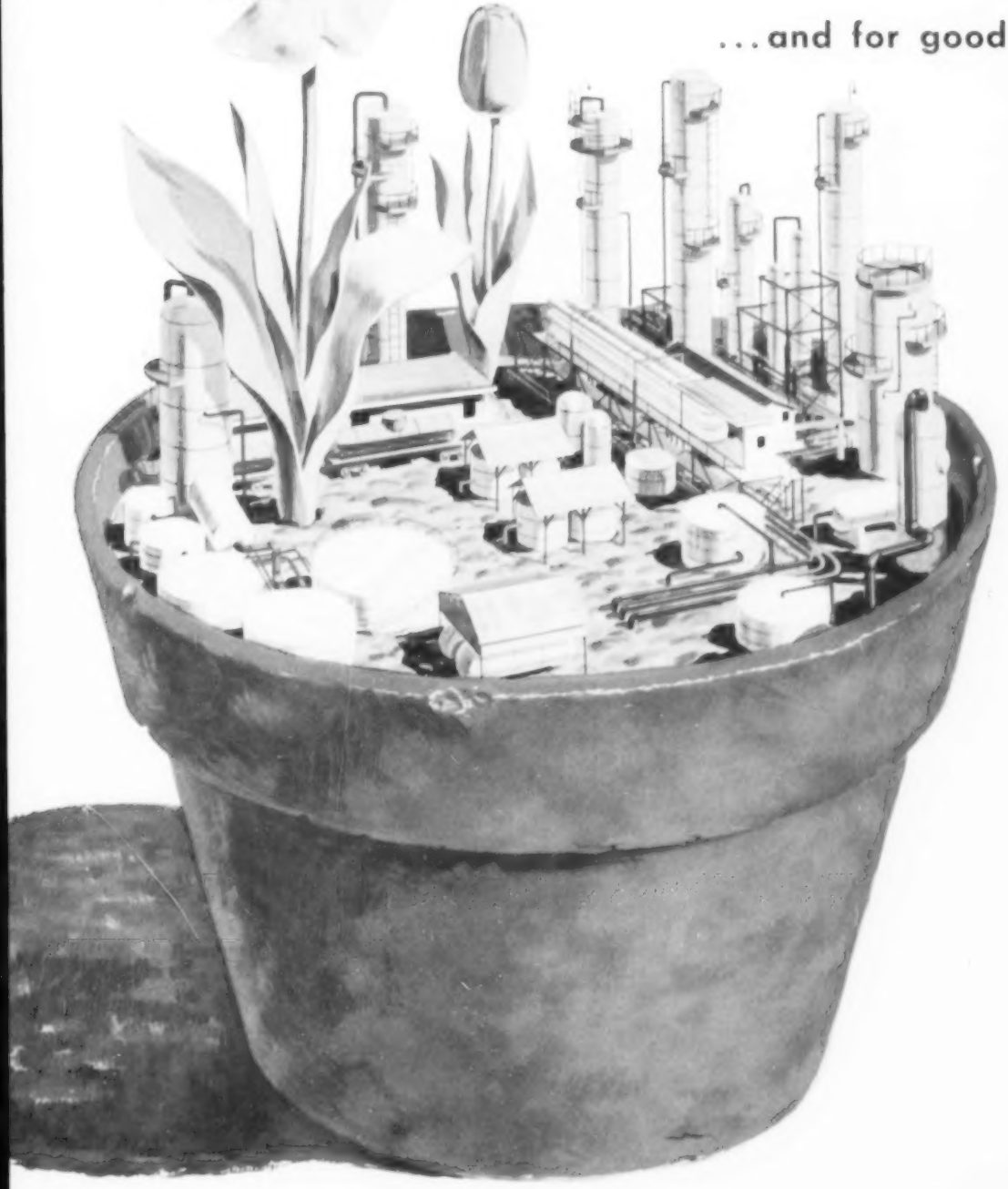
DESIGNERS, DEVELOPERS AND MANUFACTURERS OF GAS TURBINES • AIRCRAFT AND MISSILE COMPONENTS • BELLOWS • CONTROLS • HIGH TEMPERATURE COATINGS • METAL ALLOY PRODUCTS

ORONITE
CHEMICAL
COMPANY

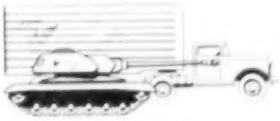
fastest growing major source for

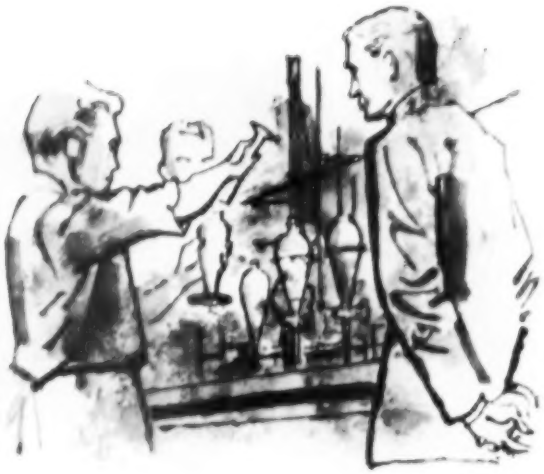
Lube Oil Additives

...and for good reason!



Oronite Lube Oil Additives

—for commercial and military oils  —where



Oronite—the leading custom-formulation source! Oronite was a pioneer in the field of additive formulations to the customer's individual requirements. The spectacular growth of Oronite, as a major additive source, can be attributed to a willingness to formulate to the customer's exact needs—meeting price and performance specifications. As proof of close work with customers, Oronite has compounded and engine tested hundreds of additive compounds and is currently supplying over a hundred different formulations.

Oronite—provides "complete-performance" additives! Oronite lubricating oil additives *impart all* the necessary performance characteristics to motor oils: detergent-dispersant properties, resistance to oxidation, rust protection, corrosion protection, reduced engine wear and engine cleanliness under low temperature operation. Most additives on the market provide some of these qualities but *Oronite additive components are balanced to give optimum performance under all types of operation, at no extra cost.* Regardless of the type of service required of the finished oil or the type of base stock available for compounding—you will get better performance from Oronite additives.

COPYRIGHT BY ORONITE CHEMICAL COMPANY 1956 ALL RIGHTS RESERVED UNDER PAN AMERICAN CONVENTION

are specified for leading branded motor oils

the highest standards of performance are demanded!

Oronite—knows the oil marketing business! Having close association with the marketing departments of major oil companies, Oronite is familiar with the problems and opportunities of the oil marketer. This way Oronite knows what your customers want from compounded motor oils. This way Oronite is constantly eager to develop new, advanced additives that provide the marketer exclusive, competitive advantages in his products.

Oronite—has a basic source for additive raw materials! Oronite, being closely allied to the petroleum industry, is assured of quality raw materials and continuous supply. A leading manufacturer of petro-chemicals, Oronite has the experience and facilities in oils and chemicals to produce the finest additive products—assuring you dependability and performance.

Oronite—major source for "single-performance" ingredients! Many major manufacturers of motor oils desire emphasis on *single performance characteristics* in their finished products. If you want added detergent—dispersant or extreme pressure wear properties, greater resistance to corrosive wear, or special low temperature performance—Oronite can provide you any of these single performance ingredients. Whatever your needs, you will find Oronite willing and capable of solving the problem.

Oronite—customer service is first and foremost!

Oronite's vastly expanded world-wide field service and technical assistance assures your questions answered directly, problems solved efficiently and deliveries made on time. Knowing and understanding local marketing conditions in any part of the world, Oronite is in position of being the most help to you.

The Oronite Chemical Company and its research affiliate, California Research Corporation, have provided many major firsts in additives. Many new and future additives are being researched now with the promise that if you do business with Oronite, you are always out in front with your products. Why not talk it over with an Oronite lube oil additive specialist? Just fill out the coupon below or contact the Oronite office nearest you.

ORONITE CHEMICAL COMPANY

Executive Offices

200 Bush Street, San Francisco 20, California

Sales Offices

30 Rockefeller Plaza, New York 20, New York

450 Mission Street, San Francisco 5, California

20 North Wacker Drive, Chicago 6, Illinois

714 West Olympic Boulevard, Los Angeles 15, California

Mercantile Securities Building, Dallas 1, Texas

Carew Tower, Cincinnati 2, Ohio

36 Avenue William-Favre, Geneva, Switzerland

ORONITE CHEMICAL COMPANY
200 Bush Street, Dept. L
San Francisco 20, California

☐ **Please have a lube oil specialist call on me regarding our requirements.**

☐ **I desire further information regarding the following properties of Oronite additives** _____

_____

Name _____ Title _____

Firm _____

City _____ State _____

The true cost of an expansion joint is not the figure on the manufacturer's price tag. Many factors enter into any such cost determination. For example, an expansion joint that fails just when it shouldn't could wreck a plant and cost a small fortune. And, assuming equal first-cost of any two competitive manufacturers' designs, one that stands up twice as long as the other . . . costs only half as much on a unit-time basis. So, one really shouldn't count on "price" as a measure of value.

But here is one thing you can count on. Every single expansion joint in the Zallea line is designed and built to assure maximum reliability —and top value for your dollar. This is no empty boast, but a fact that can be confirmed for you by figures.

So, whenever you have problems—or needs—relating to expansion joints, don't fail to get in touch with Zallea. Write today for Bulletin 351, containing condensed descriptions of the many types. There is a Zallea joint for every requirement.

Zallea expansion joints

ZALLEA BROTHERS, 822 LOCUST STREET, WILMINGTON 99, DELAWARE

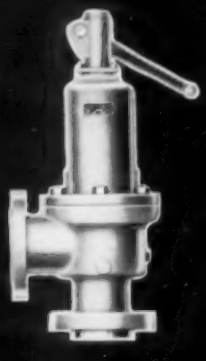
World's Largest Manufacturers of Expansion Joints

1943

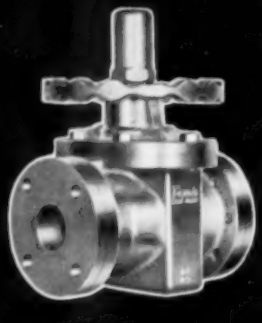
"Progress"

1944

Safety-Relief Valves
Balanseal Bellows Valves
Farris Engineering Corp.



1945

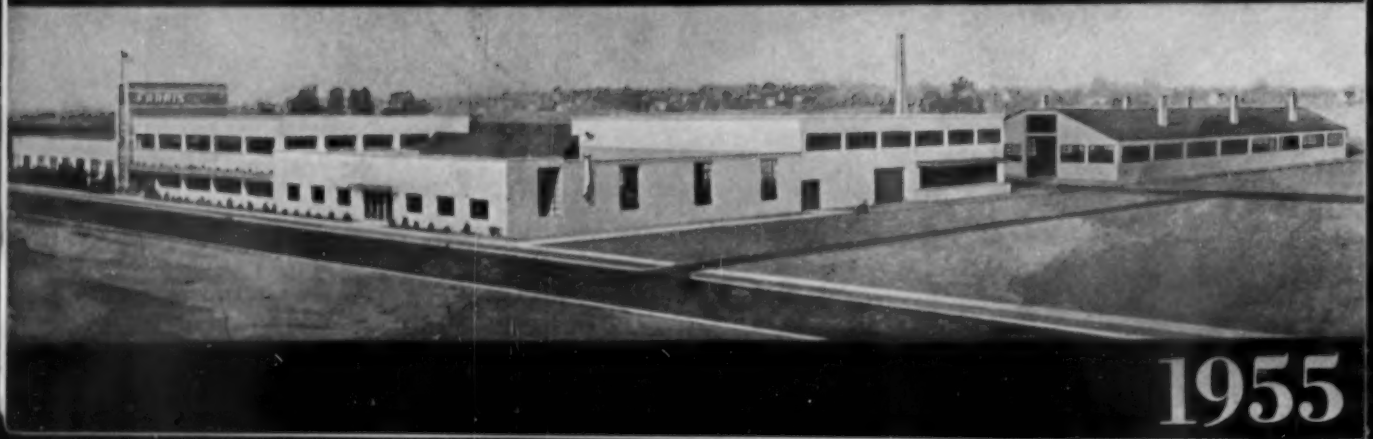


Pinch Type Flexible
Diaphragm Disc and
SuperSeal Valves
Farris Flexible Valve Corp.

1951

Mechanical and
Hydraulic Governors
Farris Pickering
Governor Co., Inc.

U. S. Patents and Patents Pending



1955

. . through honest purpose"

The larger and more experienced a manufacturer becomes, the more he appreciates that PROGRESS is not restricted to simply producing fine products at fair prices. Rather, it is the sum total of all the services he renders to his customers day by day and year by year. It is unceasing vigilance to assure customer satisfaction . . . it is constant concern for improvement—for *better* products at even *better* prices . . . it is strict adherence to a commercial code of honor, like Farris' policy of "Progress—Through Honest Purpose".

Evidence of this policy's success is seen in the rapid and constant growth of the Farris organization. And even as you read this, more facilities are being added . . . designed to provide even greater service for users of Farris Safety and Relief Valves (which have set the pace in design and performance and have been duplicated by other manufacturers), Farris "SuperSeal" Flex Valves and Farris Pickering Governors.

Behind our continuing growth and the world-wide recognition of Farris as a pacesetter in its field, is the fundamental belief that "honesty of purpose" when dealing with people is always to be trusted. Upon this belief we have grown . . . and, because they believe in the same things, our customers and friends have supported us. Here, beyond doubt, is proof that the right way to grow is THROUGH HONEST PURPOSE.

and HOUSTON, TEXAS 1955

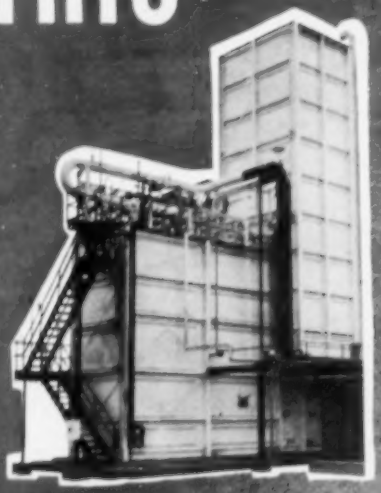
PROGRESS THROUGH Farris HONEST PURPOSE

AFFILIATED COMPANIES

400 COMMERCIAL AVE., PALISADES PARK, N. J.

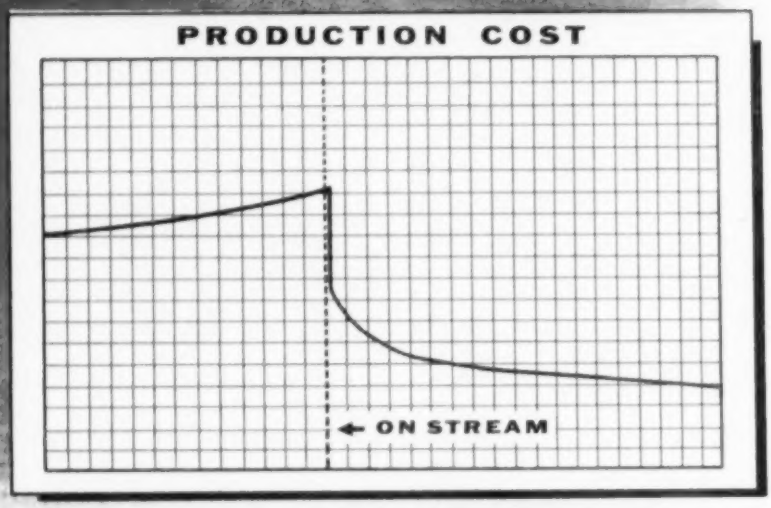
- Farris Engineering Corp.
- Farris Flexible Valve Corp.
- Farris Pickering Governor Co., Inc.
- Farris Hydrotorque Corp.
- Farris Hydroseal Corp.

When THIS



goes on stream

THIS goes down



Do you use oxygen and/or nitrogen on a large scale? Or are you contemplating expansion involving the use of oxygen? If so, we can easily prove that an Air Products "On-Location" Oxygen and/or Nitrogen station will reduce your costs—substantially.

The specialized experience of Air Products in the field of low-temperature gas separation processes is unsurpassed in this country and abroad. This background can be effectively employed to assist in formulating your plans.

We design and manufacture:
Large Capacity Tonnage Generators for unlimited quantities of oxygen and nitrogen, regardless of size, purity, or cycle

or

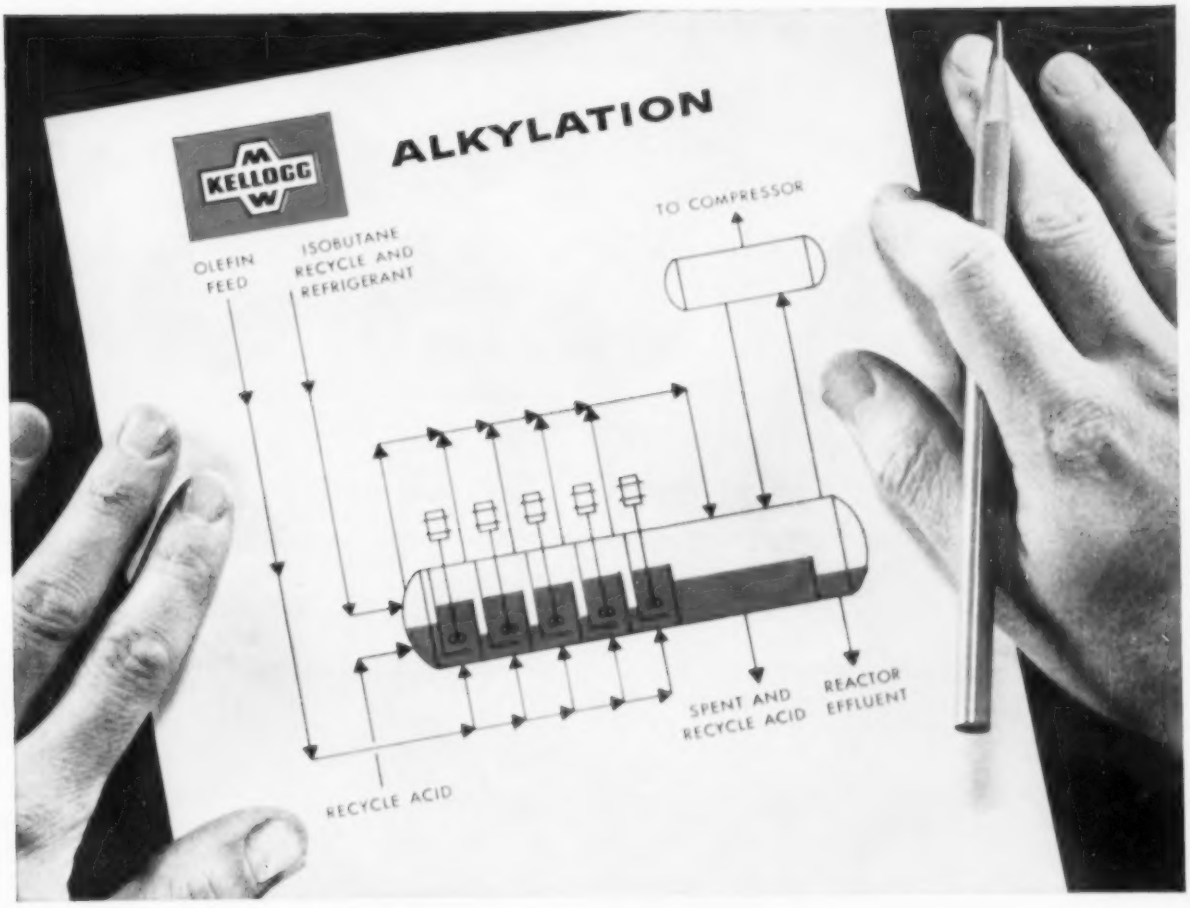
"Packaged" High Purity Generators, producing high purity oxygen and nitrogen separately or simultaneously.

Let us study your requirements and make recommendations (with comparative costs) for an installation specially designed for your particular needs.

More than 700 successful installations

Air Products
INCORPORATED
Dept. L, Box 538, Allentown, Pa.

Cost Analyses • Process Design
Apparatus Design
Apparatus Manufacture



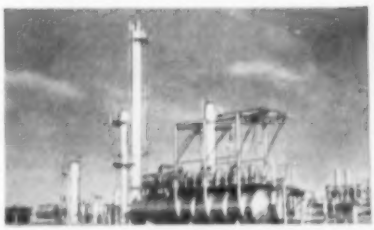
Lower Investment in Recycle Equipment with Multiple Stage Cascade Reactor

With more and more refiners expanding their alkylation capacity, attention is focussed again on the equipment economy and isobutane efficiency of M. W. Kellogg's cascade reactor as compared with earlier jet-type systems.

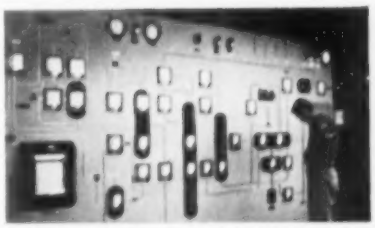
In a 2,500 BPD alkylation plant, for example, Kellogg's five-stage design reduces the number of reactors required from four to one! Instead of the approximate 12,800 BPD of isobutane recycle needed for the four individual reactors, Kellogg's single reactor requires only 4,500 BPD recycle!

In addition, the isobutane tower is reduced from 13½ to 7 feet in diameter. Exchangers, condensers, reboilers, pumps, piping, and other auxiliary equipment are proportionately smaller. And one centrifugal compressor replaces three reciprocating machines.

M. W. Kellogg welcomes the opportunity to discuss with you the improvements it is continuously making in its alkylation techniques. Recent examples are a cascade reactor with *seven* reaction zones, and the new bauxite process—developed jointly with D-X Sunray Oil Company—which reduces corrosion and fouling of fractionating units.



A recent installation of M. W. Kellogg's sulfuric acid alkylation process clearly shows the unique cascade reactor.



Control panel for units shown in the other photograph, with instruments identified by color-coded silhouettes.

Refinery Process Division

THE M. W. KELLOGG COMPANY

711 Third Avenue, New York 17, N. Y.

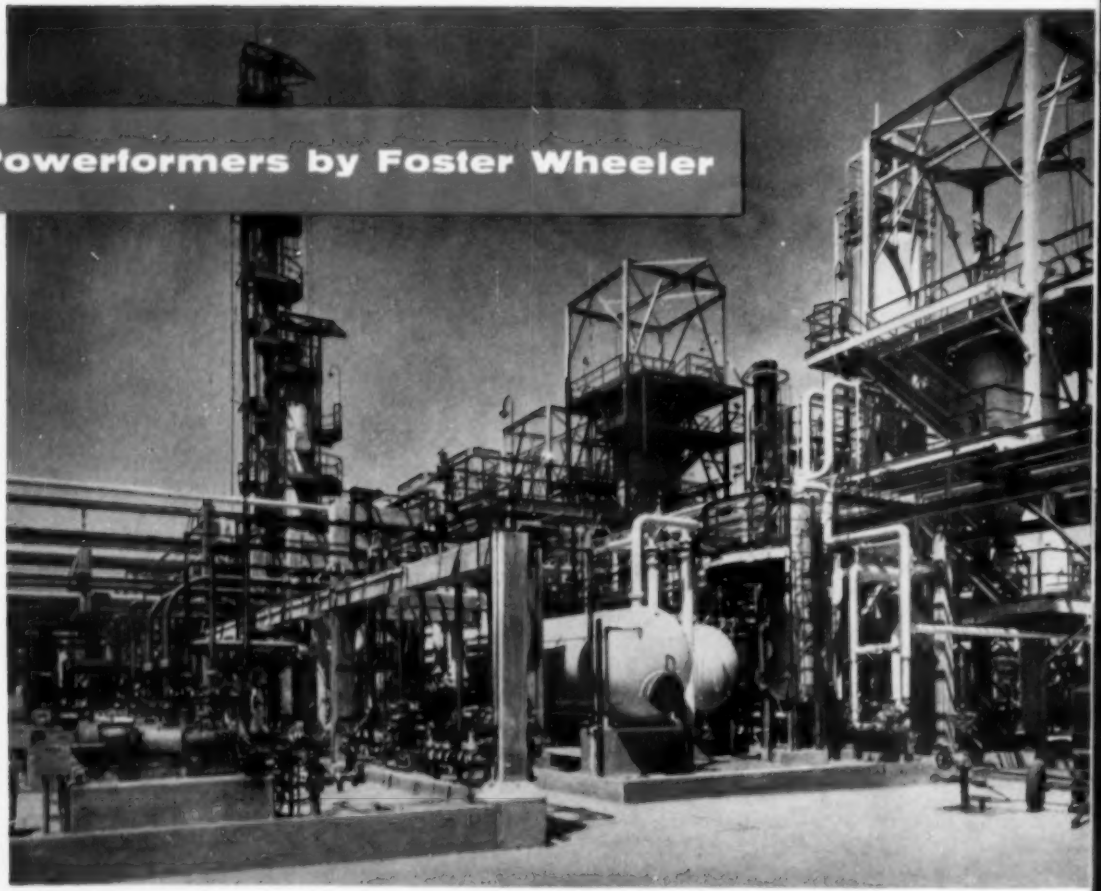
The Canadian Kellogg Company Limited, Toronto · Kellogg International Corporation, London

SUBSIDIARIES OF PULLMAN INCORPORATED

power

86.3

3 Powerformers by Foster Wheeler



This Powerforming unit, designed and constructed by Foster Wheeler for Esso's Baltimore refinery, charges approximately 3,000 barrels per day of heavy virgin naphtha which has been desulfurized in a Hydrofining unit whose operation is integrated with that of the Powerformer.

FOSTER

NEW YORK • LONDON

(To obtain more data on advertised products see page 174)

forming

percent, 98* clear

*Research Octane of Debutanized Reformate

- **New, more active platinum catalyst**
- **Special regenerative technique maintains optimum catalyst activity**
- **Lower pressure operation – 200 to 300 psig**
- **Higher yields of high octane reformate**

This combination provides the refiner with a most effective means for the catalytic reforming of low-octane naphthas into high-octane motor fuel components.

Powerforming, developed by Esso Research and Engineering, has already proved its outstanding performance on three units which are now in successful operation. Fourteen more are under construction or in the design and planning stage.

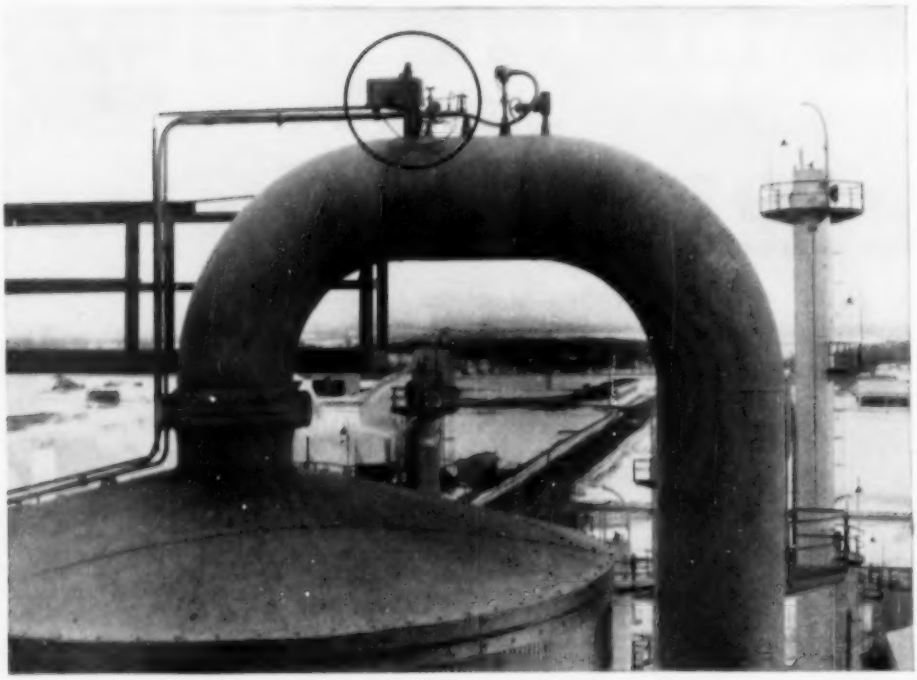
The first Powerforming unit, shown at the left, in operation since May 1955 was designed and constructed by Foster Wheeler for Esso's Baltimore refinery. FW is currently providing mechanical design and construction for two more Powerforming units – a 20,000 barrel per day unit at the Bayway refinery and a 7,000 barrel per day unit at Imperial's Halifax refinery where Foster Wheeler is also building Crude Distillation, Fluid Catalytic Cracking, Polymerization and Treating units. For further information write to Foster Wheeler Corporation, 165 Broadway, New York 6, N.Y.

WHEELER

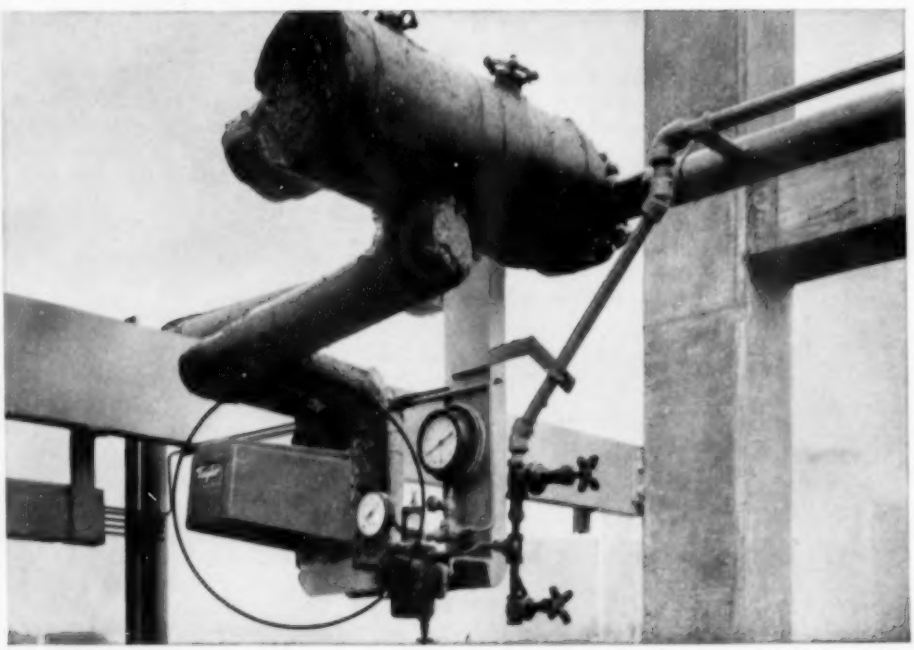
PARIS • ST. CATHARINES, ONT.

For dependable Accuracy in

GREAT NORTHERN AND FLUOR



Br-r-r! It's cold up here! Taylor TRANSAIRE* Temperature Transmitter, with derivative (SPEED-ACT*) response in the measuring circuit, measures the temperature of overhead vapors from the Syn Tower. Based on this measurement, the reflux flow to the tower is regulated by a TRI-ACT* Controller.



Taylor TRANSAIRE 333RD Differential Pressure Transmitter measuring flow of propane, at over 600 psig., used as a purge flow to the reactor. Note that the transmitter has no protective insulation . . . yet it maintains acceptable accuracy limits over the wide range of temperatures in such exposure.

*Trade Mark

Minnesota's -40° to +100°F. Climate

CHOSE TAYLOR TRANSET* SYSTEM

HIGH ACCURACY and dependability are vital requirements for instrumentation installed outdoors in Minnesota's extremes of climate. Both The Fluor Corporation, Ltd. and Great Northern Oil Company have been impressed with the performance of the Taylor instruments at the latter's new refinery at Pine Bend, Minn.

The instruments arrived on the scheduled delivery date—and in good calibration. There were a minimum of instrument problems in start-up and they were "on stream" unusually quickly. In addition to its reliability, the TRANSET system has demonstrated several important benefits to Great Northern.

1. Installation was simplified because there is only one mounting per control station—controllers plug into back of receivers; only three piping connections per station.

2. Training of new operators was simplified, because the 167-ft. graphic panel made it easy for them to visualize quickly the entire process by revealing the complete flow diagram.

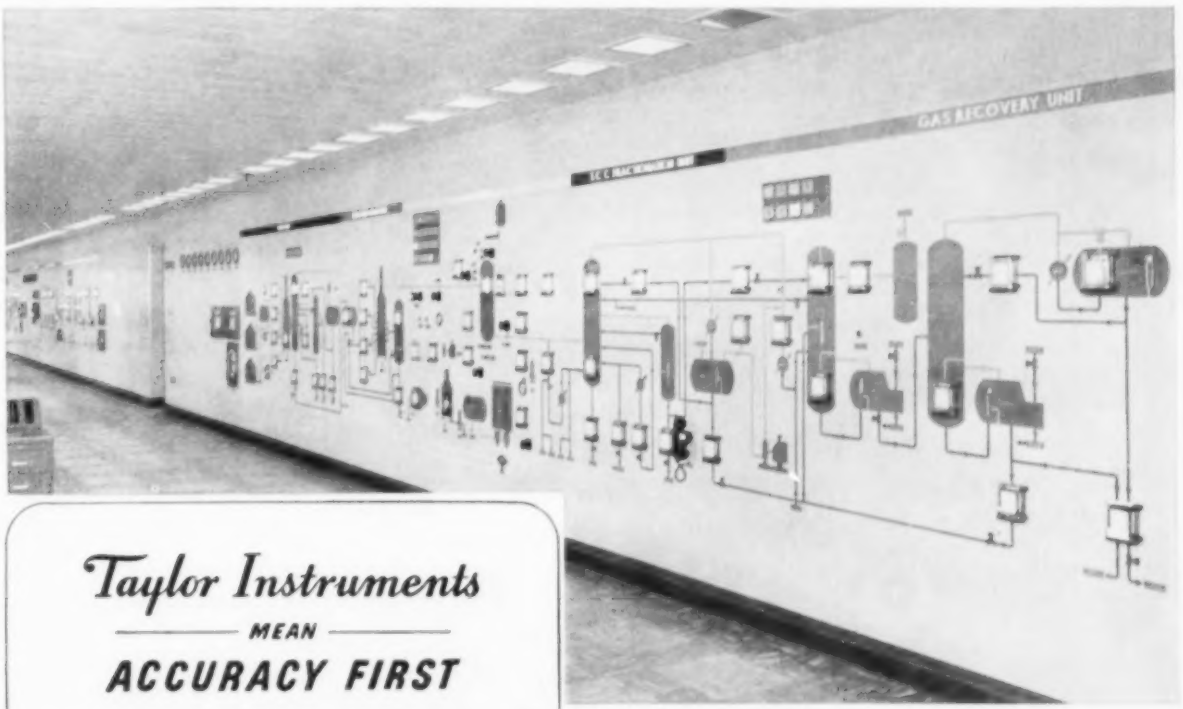
3. Training of Maintenance Personnel was facilitated by means of the plug-in feature which permitted the TRANSET Receivers and Controller to be removed to shop for training purposes—without interfering with piping of panel.

4. Routine maintenance is simplified by same plug-in feature. Checking of questionable controllers or receivers can be done in the shop. Instrument down time is kept to a negligible minimum.

5. Quick analysis of process difficulties is possible because the trend can be plotted by plugging in a recorder in place of an indicator in a matter of seconds.

• • •

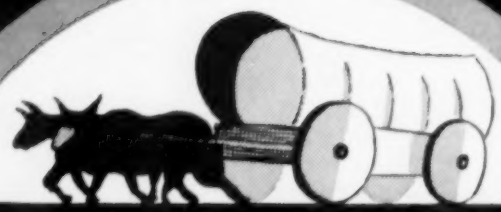
We are proud of the part Taylor experience and engineering skill have played in helping Great Northern to maintain their quality standards in their marketing area. If you're not familiar with the scope of Taylor's services, call your Taylor Field Engineer or write Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.



Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

167-Foot Graphic Panel—one of the largest in the industry—not only shows a complete flow diagram and tells what is happening at every critical point in the refining process, but also provides every facility for efficient process control.

PATENT CHEMICALS, INCORPORATED



MANUFACTURERS OF DYES AND CHEMICALS FOR THE PETROLEUM INDUSTRY

Your dependable source for...

Fluorescent colors and blooming agents used with additive compounded, solvent extracted lube oils
Dyes for gasolines, greases, waxes and industrial products
Petrol Ero Blue for Aviation gasoline
This material meets Mil-F-5572 Specification

Manufacturers of fluorescent indicator for F.I.A. absorption method hydrocarbon analysis. 'Petrol' Red AB4, a specially developed red dye for gasoline marking to meet Mil-F-5572 specifications. 'Petrol' colors for gasoline, kerosine, Diesel and tractor fuels. • 'Greasol' colors for greases. • 'Stero' colors for waxes.

Patent Chemical Company specializes in petroleum problems and preparation of particular products to meet special requirements involving dyes; fluorescent colors; additives; blooming, wetting, dispersion agents, etc.

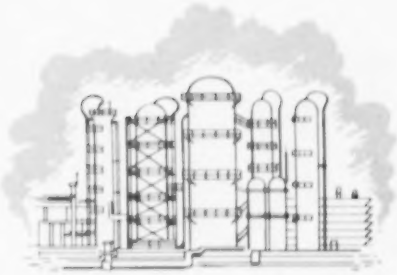
SPECIAL PRODUCTS—

Fuel Oil Additives
Turbine Oil Additives
Petrol Blue Whiteners
Deblooming Agents
Gasoline Additives
Body Colors
Asphalt Bonding Agents
Dispersing Agents

PATENT CHEMICALS INC.
Manufacturing Division: 335 McLean Blvd., Paterson 4, New Jersey

PATENT FUELS & COLOR CORP.
Marketing Division: 2410 Carew Tower, Cincinnati 2, Ohio

TRECo TRECo TRECo TRECo TRECo TRECo



DESIGN
ENGINEERING
CONSTRUCTION

TRECo

A DIVISION OF VITRO CORPORATION OF AMERICA

The REFINERY ENGINEERING Company

NEW YORK TULSA TORONTO

to meet exacting lubrication standards, specify

ENJAY PARANOX®

detergent-inhibitor additives

Refiners and blenders from coast to coast count on Enjay for a *complete* line of highest-quality petroleum additives. An important part of this line is the Enjay Paranox group, the detergent-inhibitor additives famous around the world for use with every type base stock.

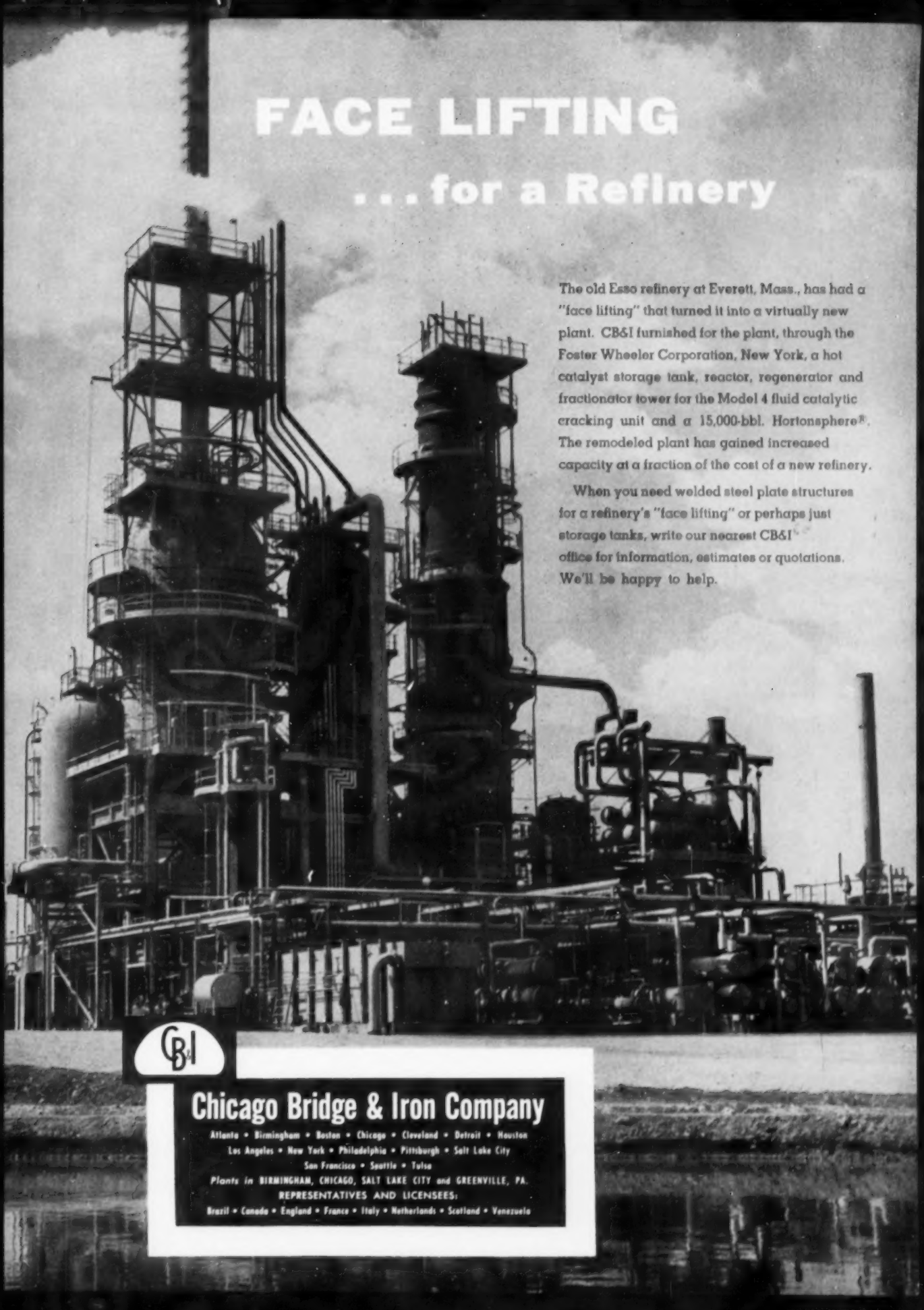
You are assured a prompt solution to your additive problems at Enjay. You get the benefit of the Enjay Company's extensive experience in working with oil companies and leading engine manufacturers to develop lubricating oil additive formulations for a wide variety of military and commercial uses.

For complete information write, wire or phone the Enjay Company—your only source for a *complete* line of additives (Paramins ®) for fuels and lubricants.

ENJAY

Pioneer in Petrochemicals

ENJAY COMPANY, INC., 15 WEST 51st STREET, NEW YORK 19, N. Y. • Other offices: Akron, Boston, Chicago, Tulsa



FACE LIFTING
. . . for a Refinery

The old Esso refinery at Everett, Mass., has had a "face lifting" that turned it into a virtually new plant. CB&I furnished for the plant, through the Foster Wheeler Corporation, New York, a hot catalyst storage tank, reactor, regenerator and fractionator tower for the Model 4 fluid catalytic cracking unit and a 15,000-bbl. Hortonsphere®. The remodeled plant has gained increased capacity at a fraction of the cost of a new refinery.

When you need welded steel plate structures for a refinery's "face lifting" or perhaps just storage tanks, write our nearest CB&I office for information, estimates or quotations. We'll be happy to help.

CBI

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.
REPRESENTATIVES AND LICENSEES:
Brazil • Canada • England • France • Italy • Netherlands • Scotland • Venezuela

Easy to Mix. Just add water according to instructions. Mixes in about five minutes.

Consistency of Mix is as workable as any cement mix.

Pours Readily into any prefabricated form.

New ALUNDUM* 33-I insulating castable...mixes and pours like concrete...protects to 3300°F.

A New Norton Refractory R_x

Now you can protect critical areas in your furnaces and other high temperature equipment to 3300°F with ALUNDUM 33-I insulating castable — a new, easy-to-install NORTON Refractory Product.

- 33-I comes in dry form in moisture-protective bags.
- 33-I — You just add water according to instructions. Mixes readily.
- 33-I pours into any prefabricated form like a concrete mix.

And . . .

- 33-I insulates up to 3300°F.
- 33-I is light in weight and monolithic in structure.
- 33-I saves down time for repairs.

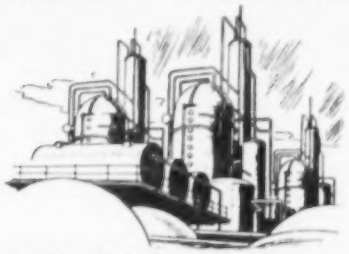
Characteristics of ALUNDUM 33-I

Density	100 lbs. per cu. ft.
Setting up time	
Stiffens	1 hr.
Initial set	4 hrs.
Final set	18-24 hrs.
Chemical Analysis — Al_2O_3	Primarily
SiO_2	< 0.1%
Fe_2O_3	< 0.1%
Maximum hot face temperature	3300°F
Water added per 100 lbs.	Approx. 4¼ gals.
Grain Size	6F

This newest Norton refractory R_x is *engineered and prescribed* for maximum protection and quick, easy installation in a wide range of uses. For further facts on ALUNDUM 33-I insulating castable, write to NORTON COMPANY, Refractories Division, 264 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Ontario.

*Trade-Mark Reg. U. S. Pat. Off. and Foreign Countries

Typical Applications in Chemical Processing



Insulation for high temperature reactors and furnaces.

NORTON
REFRACTORIES
Engineered... R_x ...Prescribed
Making better products... to make your products better

Commercial Filters Corporation acquires Honan-Crane and Michiana

Three famous names in filtration now united for greater service to industry...

A FILTER FOR
EVERY PURPOSE
Honan-Crane Oil Filters featuring a wide selection of interchangeable cartridges plus several types of bulk refill materials to provide "selective filtration" . . . exactly suited to your requirements.
Fulflo Filters in all sizes for ultra-high flow rates with lowest pressure drop. Low-cost, long-lasting Honeycomb Filter Tubes give true depth filtration in a wide range of precision-controlled densities for any desired degree of micronic filtration.
Michiana Lube and Fuel Oil Filters for diesel and gas engine service. Available in a wide selection of types and sizes.

1. **Commercial FULFLO Filters and Honeycomb Filter Tubes** . . . the original controlled density element for full flow liquid filtration.
2. **HONAN-CRANE Filters** with bulk or cartridge filter elements, and **CFC** Pre-Coat Filters, Magnetic Separators, Coolant Clarifiers and Tubular Conveyors.
3. **MICHIANA Lube and Fuel Oil Filters** for diesel and gas engines.

The addition of Honan-Crane and Michiana enables Commercial to offer you the nation's most extensive line of filters for industrial use. Fulflo Filters and Honeycomb Filter Tubes will be manufactured exclusively at Commercial's modern plant in Melrose, Massachusetts. A newly-formed Lebanon, Indiana subsidiary—Indiana Commercial Filters Corporation—will be devoted to the production of Honan-Crane, Michiana and CFC equipment.

The expanded Commercial Filters organization represents a combined total of 70 years' experience in the industrial filtration field. This wealth of experience is available on any phase of your filtration program.

DISTRICT OFFICES—
New York • Chicago • Memphis

Sales and Service Representatives in more than 30 principal cities

COMMERCIAL FILTERS CORPORATION

plants at:
Melrose, Massachusetts
and Lebanon, Indiana

(To obtain more data on advertised products see page 174)

PETROLEUM CHEMICALS DIVISION

NEWS

May * One of a Series of Bulletins for the Petroleum Industry * 1956

ONE COMPLETE LINE

Only Du Pont offers you a *complete* line of additives . . . for gasoline, for diesel and heating fuels, and for lubricating oils. Du Pont also offers grease stabilizers and dyes. To bring yourself up to date on the benefits of these products, read about them below and on the next page.

1. AN ASHLESS heating and diesel fuel oil additive. (See below.)
2. A NEW TYPE of lube oil additive that fills the growing need for low-duty detergency. (See below at right.)
3. COPPER CONTAMINATION in a wide variety of petroleum products can be controlled. (See article on Du Pont Metal Deactivator on next page.)
4. COLOR is adding new sales advantages to many petroleum products. (See next page.)
5. GREATER ECONOMY can result from purchasing Du Pont additives in carload lots. (Read about it on the next page.)
6. MULTI-PURPOSE greases for high temperature service require additional stability. (The Du Pont grease stabilizers written up on the next page can help you achieve it.)

ASHLESS additive to help you avoid oil burner and diesel troubles

Since it is a nonmetallic ashless additive, Du Pont Fuel Oil Additive No. 2 (FOA-2) does not leave a metallic ash deposit that can foul the operation of oil burner electrodes and stack controls. Also, it can be used in diesel fuels without any danger of contributing to exhaust sparking.

Many other advantages

Added to freshly prepared heating oil stocks at the refinery, FOA-2 retards the formation of insoluble residues in storage and customer tanks. It also reduces the particle size of any residues that are formed and helps to clean out any sludge deposits that might previously have formed in oil burner systems.

In diesel fuels, its stabilizing and dispersant action can help prevent injector sticking and filter plugging. In this way, FOA-2 provides a means of making economy grade, cat-cracked fuels highly acceptable for diesel operation.

New setup to expand customer service to refiners on Du Pont additives

The continuing upsurge in both volume and quality of petroleum products has increased the demand for all types of chemical additives. To meet this growing demand, the Du Pont Petroleum Chemicals Division has recently followed the lead established for TEL and streamlined its sales and technical service setup for the handling of all Du Pont additives.

J. J. **MIKITA**, right, Sales Manager, additives, and **RICHARD O. BENDER**, an Assistant Director of the Petroleum Laboratory, head up the new Petroleum Chemicals Division additives sales and technical service groups respectively.

A group under Mr. J. J. Mikita will have charge of the sale of Du Pont Metal Deactivator, gasoline antioxidants and dyes, fuel oil and lube oil additives, and grease stabilizers. In his former capacity as director of the Du Pont Petroleum Laboratory, Mr. Mikita had unusually broad experience in the development and application of all types of petroleum additives.

Mr. R. O. Bender, who has also been closely associated with the development of many Du Pont additives, will now be headquartered at the Du Pont Petroleum Laboratory. There, as an assistant director of the Laboratory,

To meet your need for low-duty lube oil detergents

Du Pont Lube Oil Additives 564 and 565 were especially developed to give effective detergency to motor oils for low-duty, around-town driving conditions. In addition to their detergency action, they will also add a substantial amount of your desired viscosity-index improvement.

Since a large part of the average motorist's driving is in stop-and-go city traffic, these unique additives offer you a strong promotional appeal for your motor oils.

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *New Service Setup*

he will be able to closely coordinate the Laboratory's work with technical service for customers.

The new setup will provide thoroughly experienced personnel ready at all times to help refiners on both technical and commercial problems concerning the use of additives.

Together, these groups will devote their entire energies toward helping refiners make the most efficient use of Du Pont's complete line of additives for gasoline, diesel fuel, heating oil, lube oil, grease and other products.

Du Pont Metal Deactivator has wide range of valuable applications

In addition to gasolines, the list of products that can be improved with Du Pont Metal Deactivator (DMD) includes diesel fuels, home heating oils, kerosines, jet fuels, turbine oils, and greases.

Wherever copper contact is a possibility, there is danger of contamination and gum formation. But in most cases, a very small amount of DMD will supply adequate protection against the harmful effects of copper.

To help you take advantage of the benefits of Metal Deactivator in many different products, Du Pont offers comprehensive technical services. And these services are geared to your own individual needs and manufacturing operations.

Convenient laboratory help

The facilities and experience of the five Du Pont regional laboratories are an important part of these services. The laboratories may be able to help you put your whole additives program on a more economical basis.

For example—because combinations of DMD and other Du Pont additives often work more efficiently than one additive alone, the Du Pont laboratory recommendations can help you achieve your desired stability with less additive . . . often at a substantially lower treating cost.

Color helps you sell, identify, add interest to MANY petroleum products

Color is becoming a bigger factor in our everyday lives . . . and in the competitive struggle for sales. You see it in the cars on the street, in home decorating, in sport shirts at the beach.

It's important in petroleum products, too. Leaded gasolines have always been dyed. And many refiners have used gasoline dyes to match their pumps, station trim and brand identification signs. Many use it for sales promotion purposes in their motor oils, also.

TO GET the best results with Du Pont additives, you are always welcome to use the services of our conveniently-located regional laboratories.

Now greases and fuel oils are becoming more colorful. And the advantages of this go beyond the promotional value. Colored greases help service station personnel and industrial lubrication engineers identify the products and check their work. Fuel oils and other products can be readily identified by grade during pipeline shipments and at other points by the simple addition of color.

For adding these advantages to *all* your products, Du Pont offers a complete line of oil-soluble dyes—yellow, orange, red, blue and bronze. Their color stability is outstanding. And they are highly concentrated for economical use.

Grease stabilizers to meet varying requirements

As operating speeds and temperatures are pushed higher, grease stability is of increasing importance.

Du Pont "Ortholeum" 300 is highly effective as a metal deactivator, as well as an antioxidant. This quality is especially important in heavy-duty industrial greases which come in contact with bearings containing brass. It also provides unusually good resistance to color deterioration.

Du Pont phenyl-alpha-naphthylamine gives excellent results in most non-catalyzed systems. Where operating conditions are not too severe and competitive pricing is important, it can be used to increase stability at relatively low cost.

To help you save on cost of additives . . .

Du Pont additives are available in carload lots.

With Du Pont Antioxidant No. 22, for example, you can save about 6% by purchasing it in tank car lots. Such a saving can mean an important profit advantage to you. And we will be glad to ship these carload lots in special tank cars, equipped with steam coils to facilitate easy unloading.

DU PONT

Better Things for Better Living
. . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.) *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

Sales Offices:

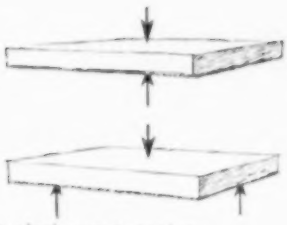
CHICAGO 3 — 8 So. Michigan Ave. RAndolph 6-8630
HOUSTON 2 — 705 Bank of Commerce Bldg. CApitol 5-1151
LOS ANGELES 17 — 612 So. Flower St. MAdison 5-1691
NEW YORK 20 — 1270 Ave. of the Americas COlumbus 5-2342
PHILADELPHIA 2 — 3 Penn Center Plaza LOcust 8-3531
PITTSBURGH 19 — Room 510, Alcoa Bldg. ATlantic 1-2933
SAN FRANCISCO 4 — Room 626, 111 Sutter St. EXbrook 2-6230
SEATTLE 3 — Room 215, 4003 Aurora Ave. MElrose 6977
TULSA 1 — P. O. Box 730 LUther 5-5578

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals—85 Eglinton Avenue East—Toronto 12, Ontario—HUdson 1-6461
OTHER COUNTRIES: Petroleum Chemicals Division—Export Sales—Room 7496 Nemours Bldg.—Wilmington 98, Del.—OLympia 4-5121, Ext. 2962

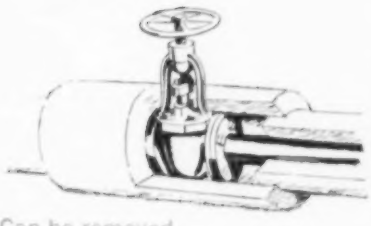
ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-1736

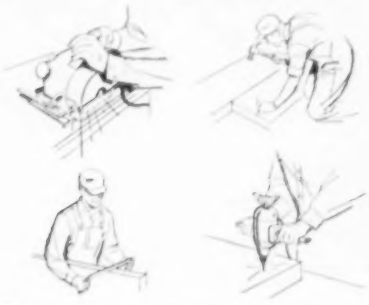
Printed in U. S. A.



Unequaled compressive and flexural strength!



Can be removed for easy line inspection . . . replaced without damage, waste!



Saw it . . . nail it . . . shave it . . . drill it!

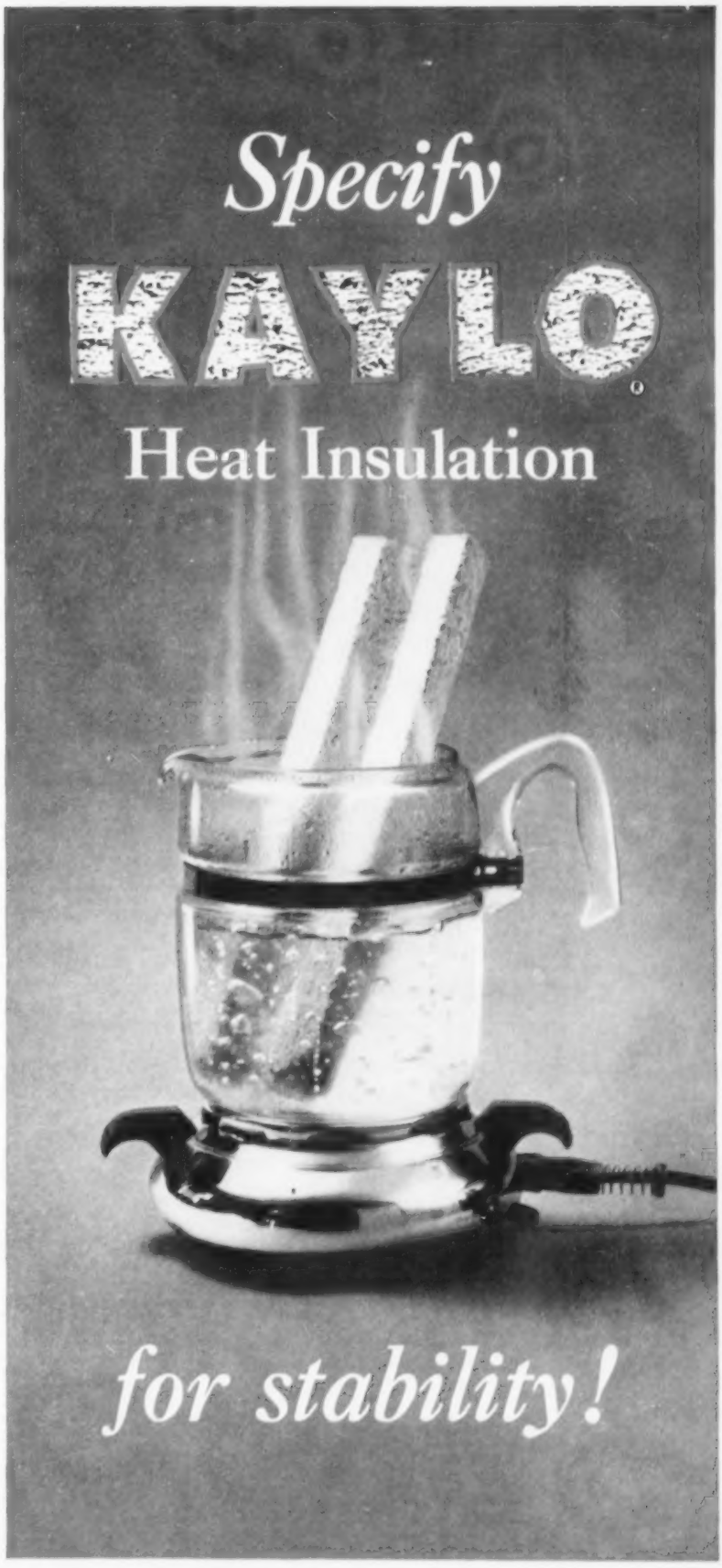
KAYLO® and FIBERGLAS*

INDUSTRIAL INSULATIONS

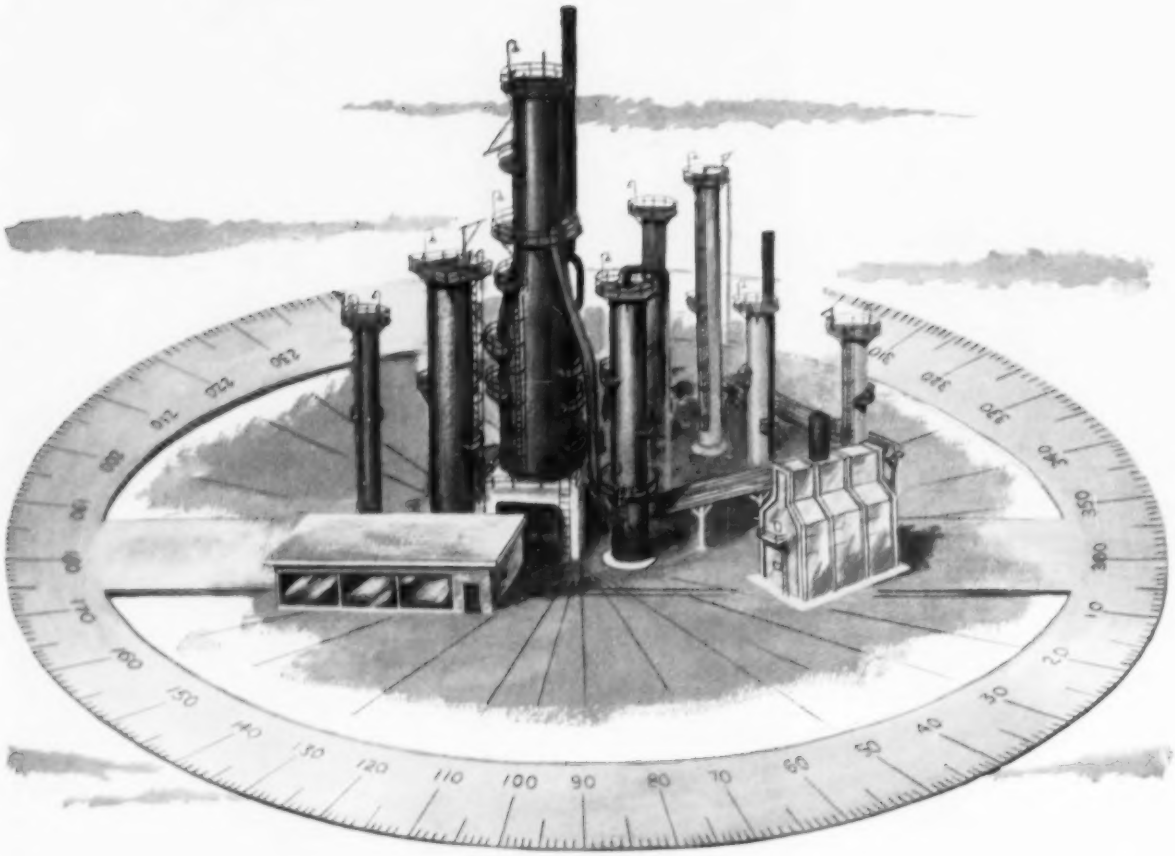
. . . distributed by approved Fiberglas distributor-contractors . . . offer the most versatile family of plant insulations available. With new *pink* Kaylo-*20* (increasing the upper range of Kaylo by 600°F.!), you can now order—from *one* reliable supplier—complete insulation coverage *from lowest sub-zero to 1800° F.*, serving such extra-high temperature applications as catalytic cracking units, refractory wall backing for furnaces and boilers, and fireproofing of piping, equipment, and vessel skirts. See *Sweet's Files*, *Chemical Engineering Catalog*, or *Refinery Catalog*. Or write: Owens-Corning Fiberglas Corporation, Dept. 185-E, Toledo 1, Ohio.

OWENS-CORNING
FIBERGLAS

*T-M. (Reg. U. S. Pat. Off.) Owens-Corning Fiberglas Corporation
® T-M. Reg. Owens-Illinois Glass Co., Inc., mfr. of Kaylo



(To obtain more data on advertised products see page 174)



PROCON COVERS EVERY ANGLE OF CONSTRUCTION

No matter how you look at it, PROCON'S dependable and complete process construction service includes every high standard of efficiency, economy, and quality. Oil refining, chemical, petrochemical companies look with confidence to PROCON for planning, engineering, procurement, construction, and inspection . . . all under ONE responsibility.

Organized to provide the broadest, most flexible services—including new plant construction, additional process facilities, expansion, or modernization—PROCON performs every function *on time, economically* and *to specification.*

Before going ahead with building or expansion plans, check with PROCON. Wherever you are, we can serve you well.

PROCON *Incorporated*
1111 MT. PROSPECT ROAD, DES PLAINES, ILLINOIS, U. S. A.

PROCON (*Canada*) LIMITED
TORONTO 18, ONTARIO, CANADA

PROCON (*Great Britain*) LIMITED
LONDON, W. C. 2, ENGLAND

WORLD-WIDE CONSTRUCTION FOR THE PETROLEUM, PETROCHEMICAL, AND CHEMICAL INDUSTRIES

GENERAL REFRACTORIES

BIRDIE... thanks to brick!

And impossible *without* brick. You would have no rubber for the ball... no steel for the clubs. You would have no mower to trim the fairways and clip the greens. And no clubhouse.

Everything made... everything that moves... owes its very existence to refractory brick... refractory brick that contains and controls the many flames of industry. Brick in infinite variety of shape and composition. There could be no industry were it not for brick.

And General Refractories, to provide the complete refractory service that industry needs, employs the world's largest, most-modern refractories research laboratory and 66 mines and manufacturing plants both here and abroad.

A Complete Refractories Service

GENERAL REFRACTORIES COMPANY

Philadelphia 2

A COMPLETE REFRACTORIES SERVICE FOR THE PETROLEUM INDUSTRY

LITECAST 50—A hydraulic-setting insulating castable refractory material, having a density of approximately 50 lbs. per cubic foot. Its extreme light weight and exceptionally low thermal conductivity make it an efficient and economical heat insulator. Recommended for vessel linings and backing for brickwork for other heavier castable refractory materials.

HIGH-STRENGTH BRIK-CAST—A hydraulic-setting castable refractory material unique in that it contains more bonding agent, which results in a product more resistant to the physical actions of impact, erosion, and load bearing. Used extensively for lining regenerator chambers and catalyst lines in catalytic cracking units.

LITECAST 50-M—A 50-pound density insulating castable, having a high degree of purity, used as a liner in vessels and lines where atmospheres must be controlled, or contamination of internals must be avoided. LITECAST 50-M may be applied in the same manner as standard hydraulic-setting castables.

BRIK-CAST 3000—A hydraulic-setting castable refractory material, composed of clays and bonding agents having the highest purity, resulting in a product with a high operating temperature (3000° F.), and resistance to reducing atmosphere in carbon monoxide attack. Recommended for sulphur burner chambers and other vessels operating above normal cracking and reforming temperatures.

This CEC 21-610 Mass Spectrometer, trailer-borne right to the drilling site, "smells" a 100,000,000-year old trace of oil . . . does it day-in, day-out for Hycalog, Inc., well-logging firm of Shreveport, La. Samples of drilling mud are analyzed for traces of gas dissolved or entrapped in the mud and cuttings. Presence of gas is a reliable indication that an oil "pay zone" is being approached, and the mass spectrometer's unusual sensitivity . . . it can detect ten parts per million of hydrocarbon gas . . . helps make sure that no potential oil reserve is passed by. "Hycalogging", the service supplied by this progressive company, is one more way that the mass spectrometer, already valuable in research and process control, serves the petroleum and petrochemical industries.

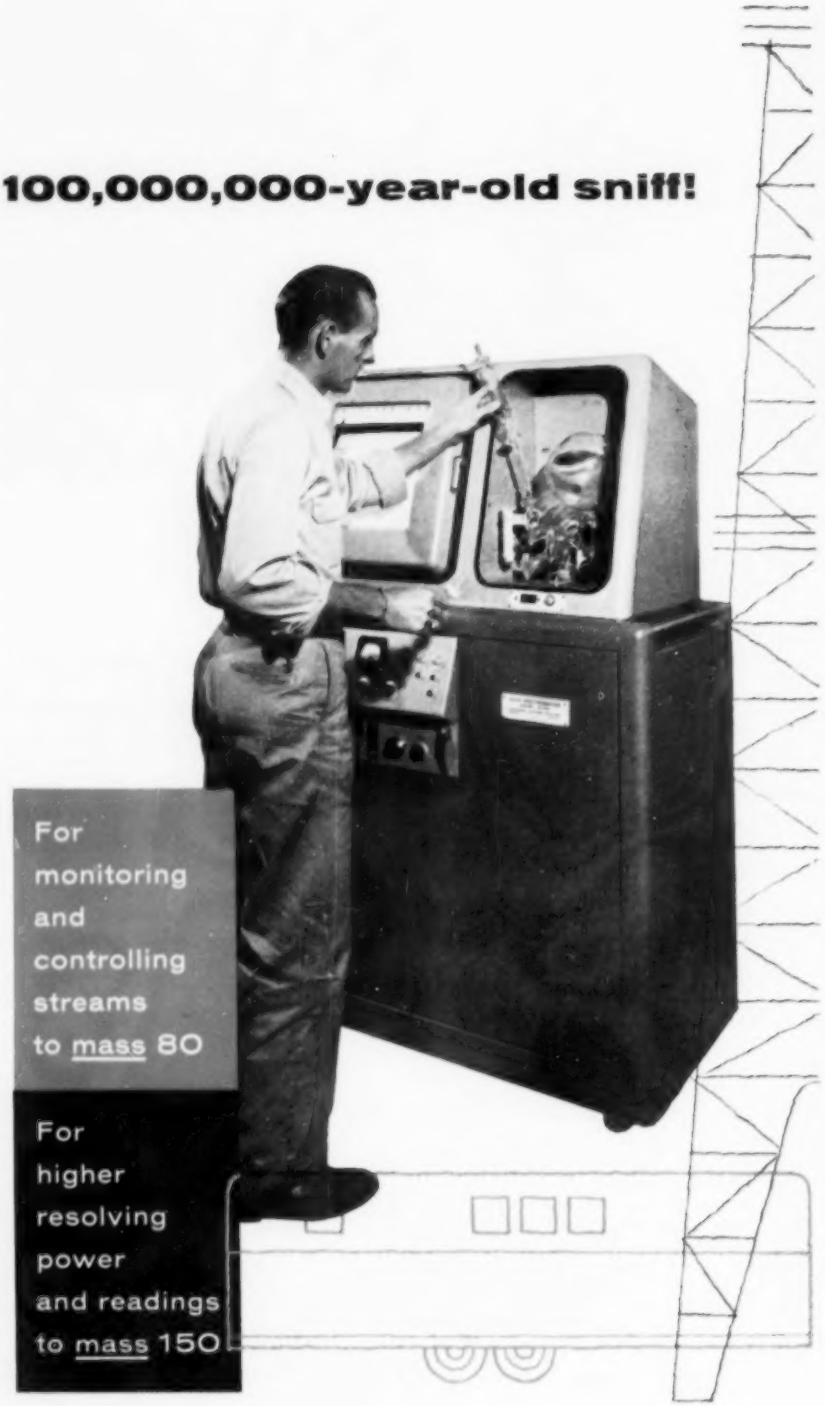
For process-stream analysis, for laboratory control, for leak detection . . . CEC offers *two* industrial mass spectrometers . . .

TYPE 21-610 is moderately priced and a truly general-purpose instrument. Although primarily designed for continuous petroleum and petrochemical stream analysis, it is also valuable for production-line leak detection or laboratory analysis. Its applications have ranged from on-the-spot acetylene-plant monitoring to hospital clinical tests on lungs.

TYPE 21-620 has the highest mass range of any instrument in its compact size range. Using the new "Cycloidal Focusing" principle, it goes beyond the 21-610 for accurate readings from mass 2 to mass 150. Medical laboratories, petrochemical plants and general research organizations will all find it ideal for their analytical problems.

Send for Bulletin CEC 1824A-X32.

100,000,000-year-old sniff!



Consolidated Electrodynamics Corporation

formerly Consolidated Engineering Corporation

300 North Sierra Madre Villa, Pasadena, California—SALES AND SERVICE OFFICES IN: *Albuquerque, Atlanta, Boston, Buffalo, Chicago, Dallas, Detroit, New York, Pasadena, Philadelphia, San Francisco, Seattle, Washington, D.C.*

Electronic Instruments for Measurement and Control

THIS IS ONE OF FOURTEEN specialized engineering groups at McKee. Modern, well-equipped quarters are completely air-conditioned. Additional facilities for our expanding organization will be provided in a new two-story building now under construction.

McKee *has the Engineers* to design your plant

● In these days of competition for engineering talent, McKee can supply the services of a large, experienced organization that is well-qualified to design your new plant.

McKee designs and builds blast furnaces, steel plants, petroleum and chemical processing plants, ore preparation facilities and industrial plants. This wide diversification of activities and our fifty-year record of successful, world-wide operation are among the factors which attract top engineers to McKee. Our large staff grows steadily and we continue to welcome applications of qualified men in many fields.

For you, this adds up to an experienced organization capable of undertaking your new plant project promptly and efficiently regardless of size or location.

McKee
ENGINEERING & CONSTRUCTION Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York, N. Y. • Union, New Jersey • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto

READ WHY SO MANY ENGINEERS AND FIELD MEN SPECIFY BOSTON HOSE AND BELTING

How to slash handling costs and downtime right now!

FROM THE MOMENT SPUDDING STARTS until the end product reaches the consumer, breakdowns chop profits and waste time. To avoid these headaches, many engineers specify Boston hose and belting. They've discovered Boston products handle the toughest jobs—turn in reliable performance on every job.

BUT THAT'S ONLY NATURAL! Boston *specializes* in rubber products for industrial use. And because it isn't just a sideline, Boston has only one aim: to continue developing products that dollar-for-dollar outperform all others.

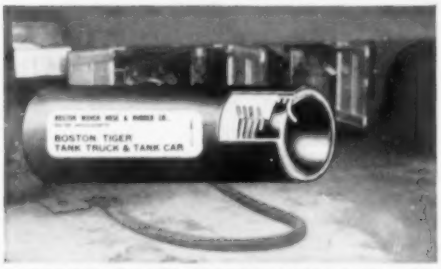
FAST DELIVERY WHEN YOU NEED IT, is next in importance after good performance. Your Boston distributor knows that. He keeps a supply of Boston hose and belting ready to meet your needs. And he knows your problems as well as he knows industrial rubber products. That's why he's your Boston Man! Call him today.

BOSTON HEAVY DUTY OIL HOSE: For loading and unloading tankers and barges. Boston has a full line of oil suction and discharge hose—all time-tested, proved sturdy. Boston hose is furnished with built-in steel or duralumin nipples. Get full details from your Boston Man.

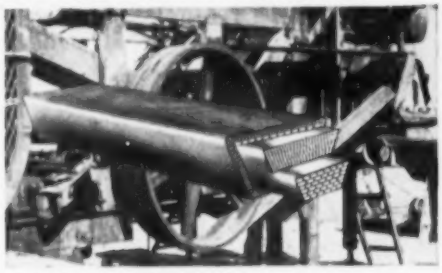
INDUSTRIAL HOSE • FIRE HOSE • BELTING

(To obtain more data on advertised products see page 174)

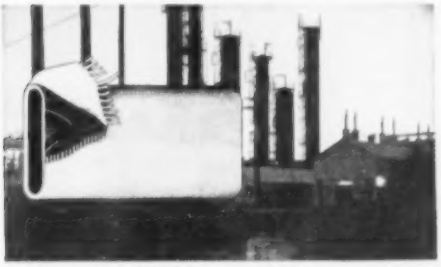
BOSTON CHECKLIST FOR YOUR HOSE AND BELTING REQUIREMENTS



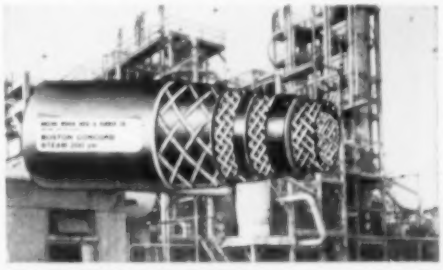
BOSTON TANK TRUCK AND FUEL OIL HOSE: Boston's seamless, synthetic tube won't flake or soften because it is unaffected by gasoline, oil, and other fuels. That means more rapid fuel transfer under all conditions. Your Boston Man will help you select the right hose for your jobs.



BOSTON V-BELTS: Muscles of tough, special cord brace *all* Boston V-Belts against slippage and shock loads. That's why they require less maintenance than other belts, deliver power more smoothly, efficiently and economically. Get the right belt for your job from your Boston Man.

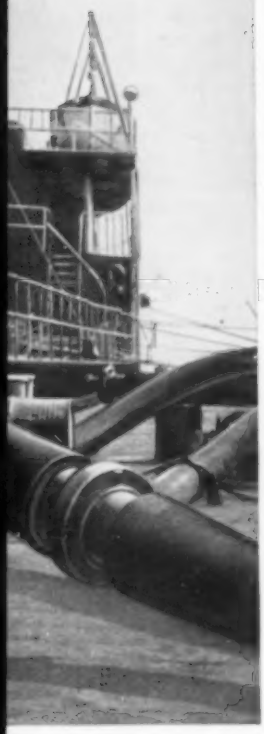


BOSTON CHEMICAL AND FIRE HOSE: Boston's complete line of chemical and fire hose lasts longer even under the toughest conditions. That's because every Boston hose is designed for a specific job, engineered to do that job more effectively. Put Boston hose to work to protect your plant!



BOSTON STEAM HOSE: Built with safety to spare, Boston Steam Hose eliminates breakdowns and handling problems on cleaning and maintenance jobs; Boston's complete line of wire-reinforced and wrapped fabric steam hose is made with time-tested, heat-resistant compounds.

BOSTON SERVICE STATION HOSE: Air hose and gasoline Curb Pump hose used in service stations must absorb rough handling, weather, dirt, grease. Boston hose is designed to take this kind of punishment. There's a full line of Boston maintenance hose for air, water and steam applications.



BOSTON Specialists

BOSTON WOVEN HOSE & RUBBER CO.
BOX 1071, BOSTON, MASS.

IN INDUSTRIAL RUBBER PRODUCTS

NEW PURCHASING GUIDE
FREE! Now—right at your fingertips—all the facts you want to know about the rubber products you use. Saves you time and money; helps you get the right equipment in a hurry. Mail coupon today!

Boston Woven Hose & Rubber Company
Box 1071, Boston, Massachusetts
Rush me a free copy of your petroleum rubber products purchasing guide.

Name_____

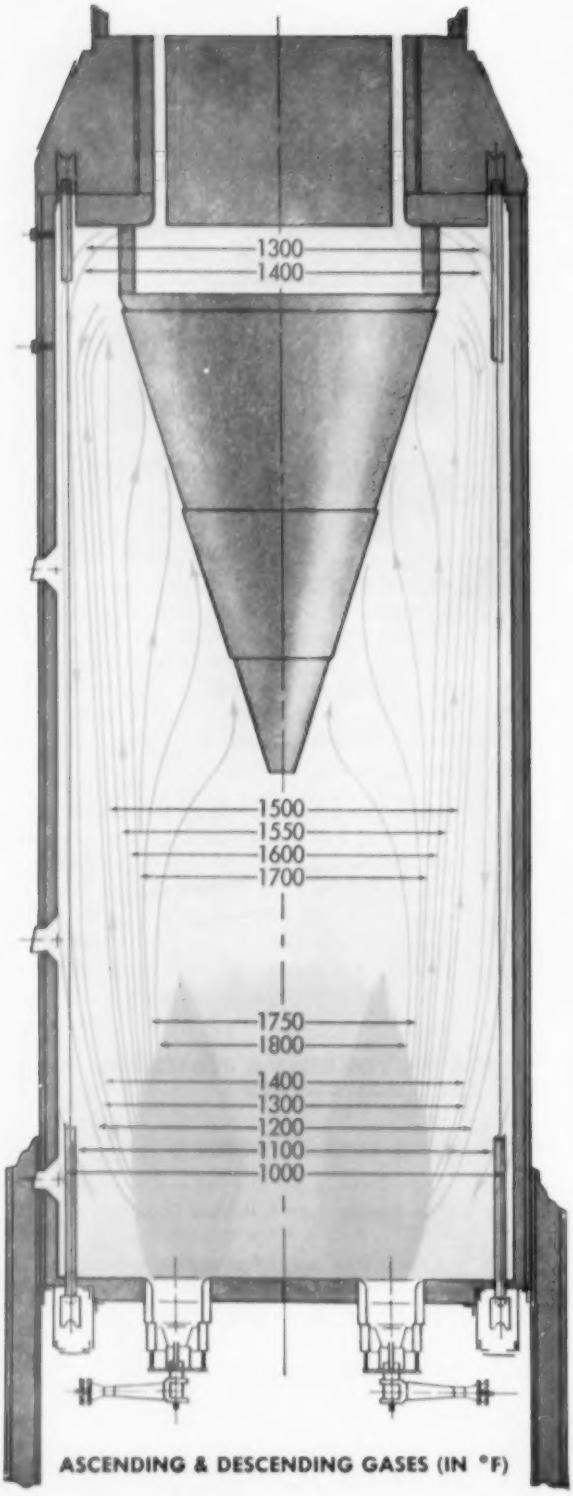
Company Name_____

Address_____

City_____ Zone____ State_____

• V-BELTS • PACKING • TAPE

PETROCHEM-ISOFLOW FURNACES



ASCENDING & DESCENDING GASES (IN °F)

Here are the facts!

The first vertical cylindrical heaters provided even circumferential heat input, but vertical flux distribution varied considerably, from high transfer at the bottom of the tubes to low rates at the top. Improvements in design during the past twenty years have overcome this difficulty, by providing proper firebox proportions, a reradiating cone, and burners specifically designed to the requirements of the furnace.

It is significant that *only Petrochem-Isoflow furnaces* incorporate all three of these critical items of design.

The small, hot cone tip reradiates to the tubes, across a considerable distance. Because of the conical shape employed, each higher element of the cone is of larger area, and closer to the tubes than the section below. These factors compensate for decrease in cone temperature from tip to base, provide relatively constant radiant heat transfer over entire upper tube length.

The cone also serves to divert flue gases along the upper ends of tubes, which adds convection heat transfer over this length. It also initiates a high rate of firebox recirculation of combustion products, by cooling the gases in their passage across the tubes.

Being cooler, and therefore heavier than the rising gases in the center of the firebox, the gases adjacent to the tubes fall to the bottom of the heater by thermal siphon effect, increasing the heat input to the rear of the heating elements by convection. The descending gases also serve as a buffer between hot gases and the lower ends of the tubes and dilute the products of combustion. The special burners, by developing a symmetrical flame pattern, contribute to the equality of heat distribution over the entire radiant tube length.

Of the design features mentioned above, the cone is of the greatest significance because it is essential to even radiant heat distribution.

Experienced operators know that even heat distribution improves product quality, decreases tube deteriorations, results in longer, trouble-free operating cycles.

The Data Shown in the Drawings are ACTUAL PERFORMANCE RECORDS!

To check radiant flux distribution in Petro-Chem furnaces, exhaustive tests were made under actual operating conditions; some of the results of these tests are indicated in the two adjacent drawings.

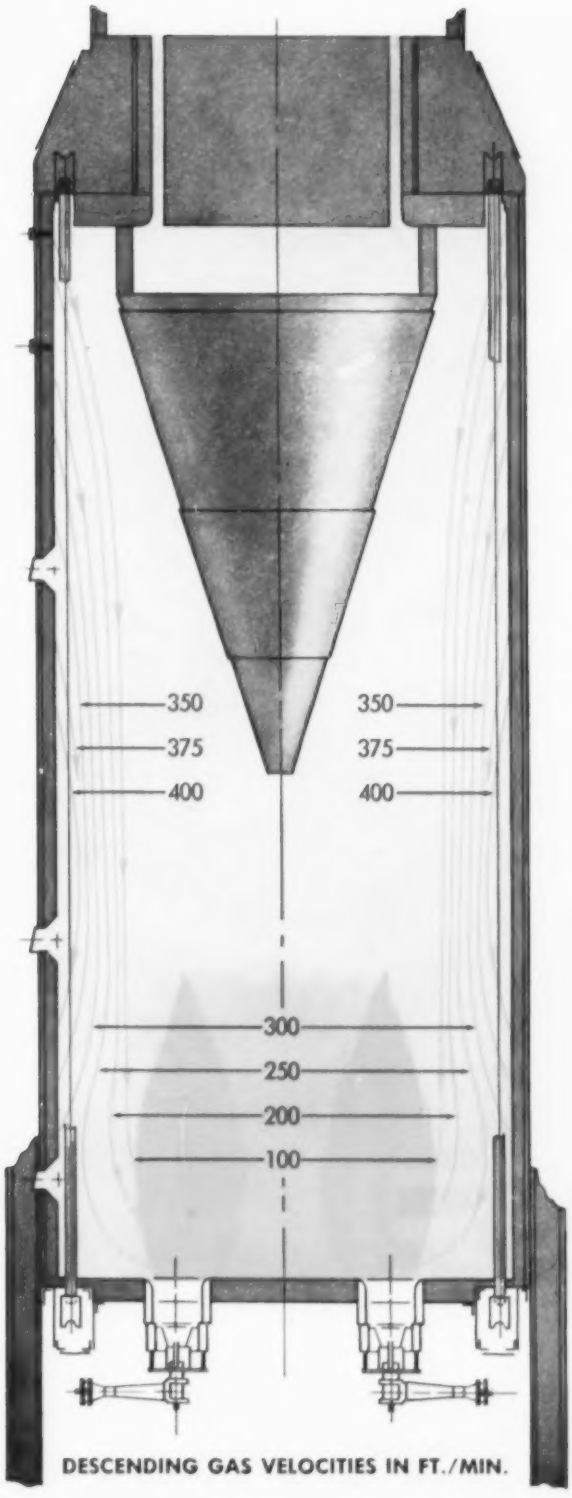
Left: Plot of isotherms in a Petrochem-Isoflow firebox, illustrating the uniformity of firebox temperature.

Right: Plot of flue gas flow patterns and velocities, demonstrating the high gas recirculation rates.

Both of these phenomena are the result of proper firebox proportions, the two-fold action of the cone, and symmetrical flame pattern.

(To obtain more data on advertised products see page 174)

Provide EVEN HEAT Distribution !



In addition to even heat distribution, other all-important factors which determine the value and efficiency of processing furnaces include:

MAXIMUM FUEL EFFICIENCY
PLENUM CHAMBERS FOR HAZARDOUS AREAS
SIMPLICITY OF DESIGN AND CONSTRUCTION
EXCESS DRAFT FOR HIGH OVERLOAD
EXPLOSION RESISTANT
MINIMUM GROUND SPACE
SHORT LENGTH OF LIQUID TRAVEL
ZERO AIR LEAKAGE
LOW PRESSURE DROP
LOW MAINTENANCE

In every case where these 11 all-important design characteristics were employed to compare one type of furnace design with another, PETROCHEM-ISOFLOW FURNACES were proved more economically desirable by any comparison.

More than 1200 Petrochem-Isoflow Furnaces have been installed since 1930 on unqualified record of acceptance based on proved performance.

PETROCHEM
—ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT COMPANY, INC.
122 East 42nd Street, New York 17, N. Y.

REPRESENTATIVES:
Rawson & Co., Houston • William H. Mason Co., Tulsa • Lester Oberholtz, Los Angeles • Faville-Levally, Chicago • D. D. Foster, Pittsburgh • Turbex, Philadelphia • Flagg, Brackett & Durgin, Boston • G. M. Wallace, Denver & Salt Lake City

International Licensees and Representatives:
SETEA — S.A. Comercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentina • Industrial Provesdora, Caracas, Venezuela • Birwelco Ltd., Birmingham, England • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge, Liege, Belgium • Heurtey Italiana S.P.A., Milan, Italy

(To obtain more data on advertised products see page 174)

A Better Diet for 300 Horses!

As automotive engines reach new horsepower and compression ratio heights, refiners must be ready with super-fuels necessary for their full measure of performance. After all, a diet made for 50 horses just won't do the job for 300.

For more than 40 years, Universal has made available to refiners everywhere new and more economical processes for producing the improved petroleum products needed to meet market requirements. These processes include:

CONTINUOUS THERMAL CRACKING, the first major improvement in refining methods, developed by UOP in the industry's early days.

POLYMERIZATION, a catalytic process developed by UOP and used to convert refinery waste gases into premium quality gasoline.

FLUID CATALYTIC CRACKING, developed to produce greater yields of liquid products and higher octane number gasoline.

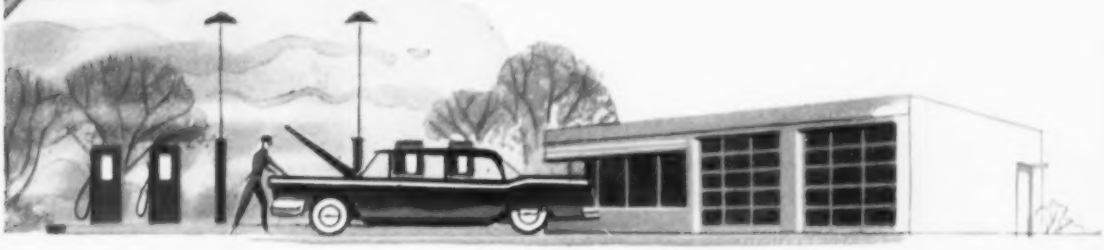
PLATFORMING, with which UOP pioneered the use of platinum in a reforming catalyst and originated the commercial designs of catalytic reforming units.

REXFORMING, a combination of UOP Platforming with solvent extraction which permits a refiner to produce even higher octane gasolines.

"HF" ALKYLATION, a process developed by UOP for producing alkylate, a high octane gasoline blending component, using hydrofluoric acid as the catalyst.

UNIFINING, the process which employs by-product hydrogen from UOP Platforming units to remove sulfur, nitrogen, oxygen and metallic impurities from petroleum distillates by catalytic hydrogenation.

These and other UOP processes, individually or collectively, can provide the answer to most refining problems. We will be glad to tell you how they can help with yours.



UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD, DES PLAINES, ILLINOIS, U. S. A.

Forty Years of Leadership in Petroleum Refining Technology

you can meet your needs

exactly

Ethylene Glycols

Ethanolamines

For Gas Purification—Mono- and diethanolamine of uniform purity for H_2S and CO_2 scrubbing. Mathieson production consistently meets standard specifications.

For Gas Dehydration—Di- and triethylene glycol with the most important specification: "convenient availability." Stocks of Mathieson products are located to give prompt service in all important refining areas.

For Selective Extraction—Diethylene glycol with highest purity specifications is the answer. Olin Mathieson can supply to meet your most exacting requirements.

For Other Uses—You need a variety of chemicals. You can satisfy many of your requirements from Mathieson's wide line of ethylene oxide derivatives.

Ask us to meet your particular need exactly. Write or call.

MATHIESON CHEMICALS
OLIN MATHIESON CHEMICAL CORPORATION
INDUSTRIAL CHEMICALS DIVISION · BALTIMORE 3, MD.

3624

INORGANIC CHEMICALS: Ammonia · Bicarbonate of Soda · Carbon Dioxide · Caustic Soda · Chlorine · Caustic Potash · Hydrazine and Derivatives · Hypochlorite Products · Muriatic Acid · Nitrate of Soda · Nitric Acid · Soda Ash · Sodium Chlorite Products · Sulphate of Alumina · Sulphur (Processed) · Sulphuric Acid

ORGANIC CHEMICALS: Ethylene Oxide · Ethylene Glycols · Polyethylene Glycols · Glycol Ether Solvents · Ethylene Dichloride · Dichloroethylether · Formaldehyde Methanol · Sodium Methylate · Hexamine · Ethylene Diamine · Polyamines · Ethanolamines · Trichlorophenol · Polychlorobenzene · Trichlorobenzene

IF YOU CAUSTIC WASH

REMOVE NITROGEN BASES & ARSENIC

ACID TREAT · SWEETEN · DOCTOR TREAT

PETRECO®

ELECTROFINING

helps you save on installation, operation and insures better products

Petreco Electrofining equipment saves up to 70% on installation, because Electrofining equipment is a once-through, single unit installation. It requires smaller area, less piping, fewer pumps. Petreco Electrofining is an automatic continuous process, insuring economical operation. Precision controls assure that the distillate is contacted with exactly the correct amount of treating agent in the proper intensity, for a set, pre-determined time. This precision treating gives a clean separation of hydrocarbon and chemical agent phases, minimizing carry-over and product losses.

Electrofining insures a better product by removing the reaction products of chemical treatment which normally contribute to the haze problem. Total metals in the Electrofined product average less than 1 PPM, and the product easily passes market specifications such as Federal Alkalinity Tests, etc. Get complete information today. JUST CALL OR WRITE —

PETRECO®

A DIVISION OF PETROLITE CORPORATION

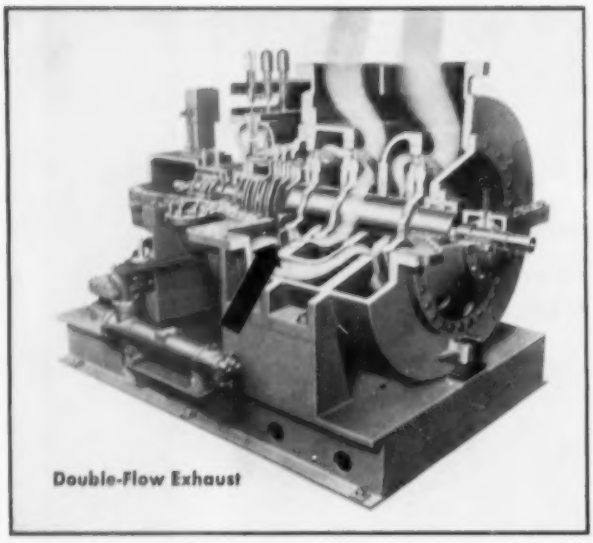
3202 So. Wayside Drive, Houston 1, Texas

1390 E. Burnett Street, Long Beach 6, California

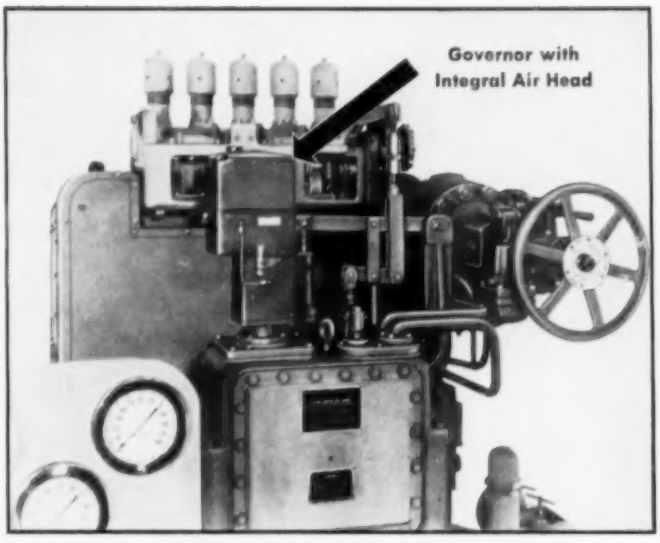
DTC-3B

· SCRUB · WATER WASH ·

In high-speed turbines . . . why does in total horsepower and



GREATER RELIABILITY. Worthington's rugged construction pays off in extra reliability. Solid rotor for modern high speeds, double-flow exhaust where large volumes of steam are used in condensing operation, and Kingsbury type thrust bearings are just a few of the features that assure safety and dependable service on your vital compressor and blower drives.



ACCURATE SPEED REGULATION. Exclusive Worthington governing system using governor with integral air motor gives you speed control response to .04 psi change in control pressure. And it provides for remote automatic operation if you need it. The oil relay type governor so equipped instantaneously controls pressure or volume delivered by the compressor regardless of steam variations.

Where turbine-driven compressors and blowers are used, down-time is usually mighty expensive. Particularly so if failure can bring a continuous process to a standstill. In the case of high-speed/high-horsepower compressor-drive turbines, your surest way to design reliability into your plant is to specify the turbine line with best *proven* performance.

Compressor-drive turbine installations up to 12,000 rpm, and 24,000 hp, show Worthington leads in application engineering, design, reliability.

Worthington compressor-drive turbines are conservatively built with all stresses carefully calculated and kept well within established safety margins. Also, measured load tests are performed on every unit at the factory with modern facilities, under the watchful eyes of highly trained personnel.

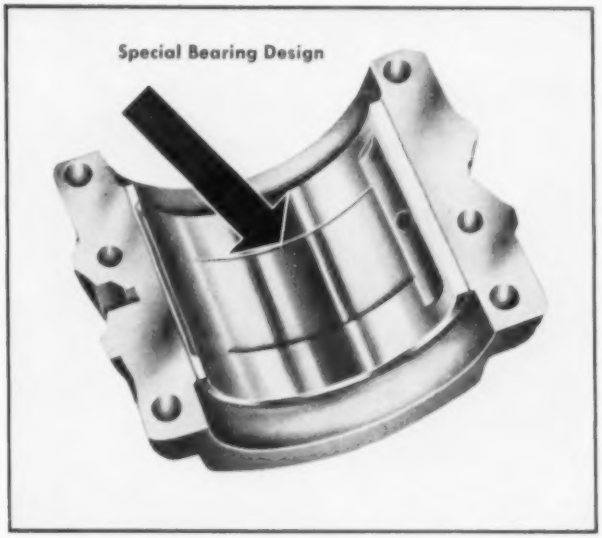
One feature seldom claimed is that of lowest price. That is inconsistent with quality, and quality is something Worthington engineers will not compromise. For critical operations, buying the best is lowest cost insurance against process equipment failure.

Get the complete story of high-speed/high-horsepower compressor-drive turbines by writing Worthington Corporation, A&SP-Turbines, Harrison, New Jersey. Ask for your personal copy of Bulletin 1966.

On Vital Compressor and Blower-Drive Applications . . . It Costs Less to Invest in the Best!

WORTHINGTON

WORTHINGTON lead all others number of installations?

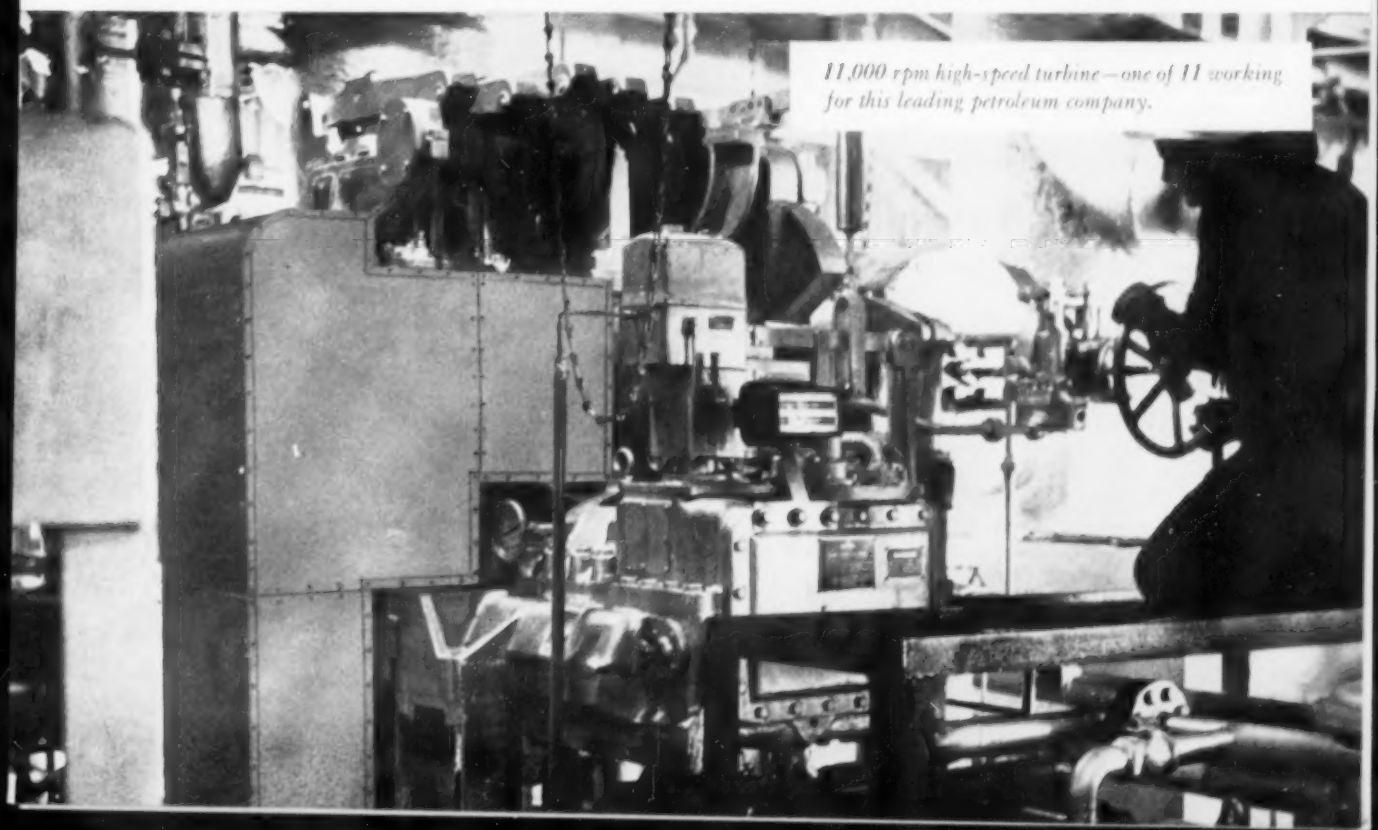


To meet turbine spec's. 4000 Hp- 7250 RPM -Steam 210 #-550° -26½"
WORTHINGTON GIVES YOU ALL THIS—CHECK AND COMPARE:

	Feature	WORTHINGTON	Company A	Company B	Company C
Rotor	Solid—to withstand extreme stresses.	✓			
Main Bearings	Anti oil-whip—for longer turbine life.	✓			
Thrust Bearing	Kingsbury type—for proven reliability.	✓			
Automatic Nozzle Control	Cam operated—for economy and better control.	✓			
Governor	Has integral air motor—for more accurate control.	✓			
Type Construction	Double flow exhaust for economy and long life.	✓			
Packing	Labyrinth—for most effective seal at high speed.	✓			
Test	Load test—to be sure you get what you ordered.	✓			

LOWER MAINTENANCE COST. One important example of construction used to help eliminate non-scheduled maintenance is Worthington's anti oil-whip bearing. During operation a pocket (arrow) in the upper half of the bearing builds up a pressure pad of oil. High pressure here creates a downward force on the journal, holding it in place in the bearing, preventing destructive vibration.

LONGER LIFE. A long, trouble-free life can be attributed to no *one* turbine feature, but rather a combination of many engineering advances. Compare design features yourself, one by one. Far ahead of any other manufacturer in the compressor-drive field, Worthington's first compressor-drive turbine built in 1927 is still working around the clock, in a large Eastern gas plant.



11,000 rpm high-speed turbine—one of 11 working for this leading petroleum company.

Old hands at solving new insulation problems

Your **J-M Insulation Contractor** knows the answers that give you a better, more economical job

To be sure of getting the most efficient insulation for your plant or equipment, see the man with the world's most complete engineering and application service. He's your J-M Insulation Contractor who brings to every job the accumulation of Johns-Manville's 95 years' experience in the thermal insulation field.

J-M Insulation Engineers work hand in hand with J-M Insulation Contractors. Together they have achieved outstanding results with some of the most intricate insulation problems . . . of every type and size—in every industry.

J-M Insulation Contractors provide a complete selection of Johns-Manville quality materials. They will choose from their own stocks the best insulation for your conditions within the broad temperature range extending from minus 400F to plus 3000F.

Skilled application is a major contribution your J-M Insulation Contractor brings to every insulation job. His skilled mechanics have mastered the latest application techniques that assure you top-quality installation . . . give maximum operating economy and lower maintenance costs.

For undivided responsibility on all your insulation requirements, call your J-M Insulation Contractor. Write for the name of the one nearest you. Address Johns-Manville, Box 60, New York 16, New York. In Canada, Port Credit, Ontario.

JM PRODUCTS

Johns-Manville *first-in* **INSULATION**

MATERIALS · ENGINEERING · APPLICATION

(To obtain more data on advertised products see page 174)

STOP COLOR DEGRADATION in distillate fuels

WITH *Nalco*

FUEL OIL TREATMENTS

Pronounced color degradation and sludging tendencies evident in this distillate fuel appeared *after* only 2½ *months* storage.

Despite extreme instability of the oil, Nalco treatment was effective. Note much lighter color of treated sample . . . same oil, same storage period.

COLOR degradation is a sure profit-cutter in fuel oils . . . but Nalco stabilizing treatment is the low-cost way to *stop* color degradation, keep oils refinery-fresh looking and acting.

Samples illustrated were refined from a highly sour crude; T.C.C. processed. Finished product was very unstable and color degradation occurred quickly in storage. Addition of Nalco treatment has greatly increased stability . . . helped stop both color degradation and sludge formation.

Regardless of your crude charge characteristics or processing methods, you can depend on your Nalco Representative to recommend treatment that will inhibit color degradation and keep your fuel oils at top salability. Write for Technical Data on Nalco Fuel Oil Treatments—or hand us your problem for a prompt, practical solution.

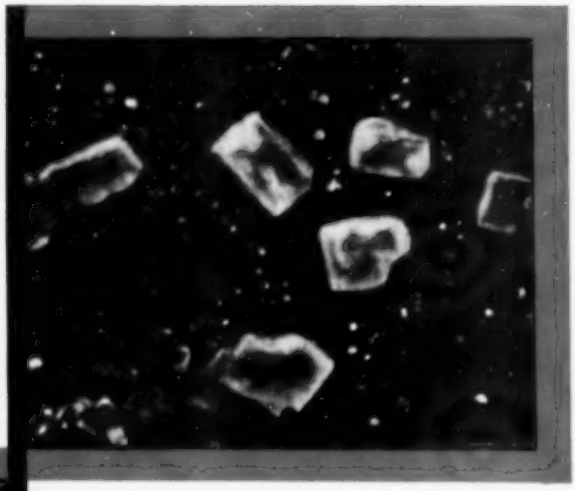
NATIONAL ALUMINATE CORPORATION
6216 West 66th Place • Chicago 38, Illinois
CANADA: *Alchem Limited, Burlington, Ontario*
NORTHWESTERN UNITED STATES, HAWAII AND ALASKA: *The Flox Company, Inc., Minneapolis 3, Minnesota*
ITALY: *Nalco Italiana, S.p.A.* SPAIN: *Nalco Espanola, S.A.*
WEST GERMANY: *Deutsche Nalco-Chemi GmbH*

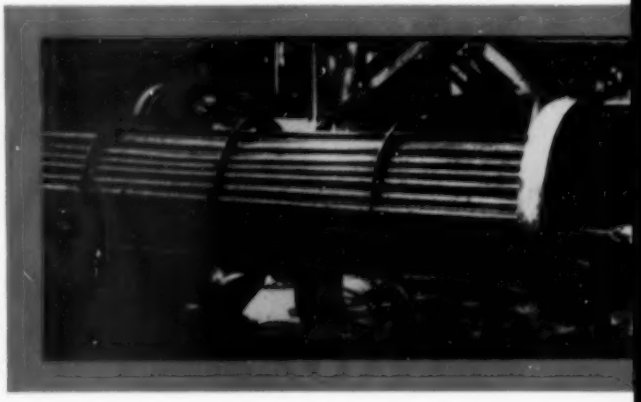
THE *Nalco*® **SYSTEM . . . Serving the Petroleum Industry through Practical Applied Science**

the high price of

SALT

is lost on-stream time





Usually considered a cheap household necessity, salt often is an expensive refinery nuisance. In the refinery, salt causes plugging, fouling and scaling, and is the source of evolved hydrochloric acid, a destructive corrodant. While plugging, scaling, fouling and corrosion are costly in the corrective measures they make necessary, the real cost is in lost time-on-stream.

Salt troubles are best eliminated by preventing salt from entering the refining equipment. Tretolite Chemical Desalting removes salts from the charging crude in the 98 to 100 per cent range. Tretolite Desalting also removes proportionate amounts of abrasive and plugging elements such as "fines,"—sand, silt, rust particles, etc. In addition, the "washing" action in Tretolite Chemical Desalting eliminates proportionate quantities of arsenic, a damaging catalyst poison.

Don't pay the high price of a salty crude charge. Your Tretolite Refinery Service Engineer will be glad to discuss the advantages of refining salt-free, washed crude. Why not call him today?

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

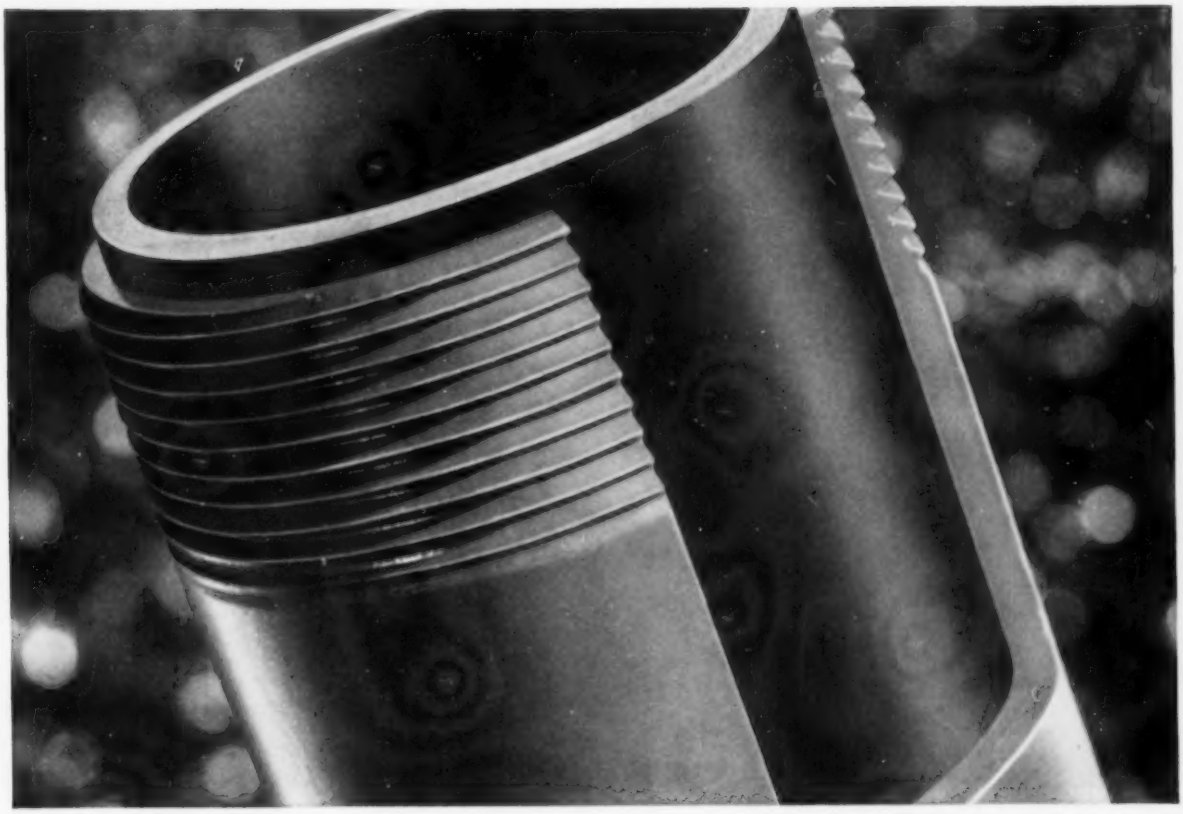
369 Marshall Avenue, Saint Louis 19, Missouri
5515 Telegraph Road, Los Angeles 22, California

Specialized Chemicals and Services for the Petroleum Industry

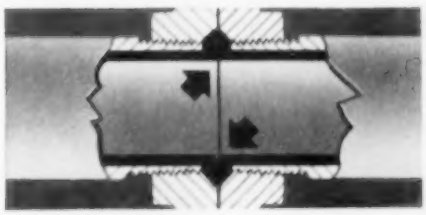
DEMULSIFYING • DESALTING • WATER DE-OILING • CORROSION PREVENTING
PARAFFIN REMOVAL • SCALE PREVENTING
PRODUCTION STIMULATION
METAL DEACTIVATING

TD 56-13

DOW



You can see why Saran Lined Pipe prevents corrosion



Liquid never touches metal in Saran Lined Pipe even at a flanged connection like this.

Acids, alkalis and other corrosive liquids never touch the rigid steel pipe . . . it's continuously lined with durable, corrosion-resistant saran

Say good-by to corrosion problems when you install saran lined pipe, fittings, and valves. This combination of corrosion-resistant saran swaged into rigid, non-bursting steel has a proved record of corrosion prevention in the chemical, petroleum, waste, pulp and paper, metal finishing and food processing field.

Saran lined pipe, fittings and valves form tight, snug, leakproof joints . . . is available for working pressures up to 150 psi. Fittings and valves are also available in steel for working pressures to 300 psi. You'll be amazed how easy and economical it is to install this modern piping, too. For it can be cut and threaded in the field with available pipe fitters' tools. And because it's rigid, a minimum of supporting structures are needed.

For further information on saran lined pipe, fittings, and valves send in the coupon on the right today. THE DOW CHEMICAL COMPANY, Midland, Michigan.

Saran Lined Pipe Company
2415 Burdette Avenue
Ferndale, Michigan

Dept. SP627F

Please send me information on saran lined pipe, valves, and fittings.

Name _____ Title _____

Company _____

Address _____

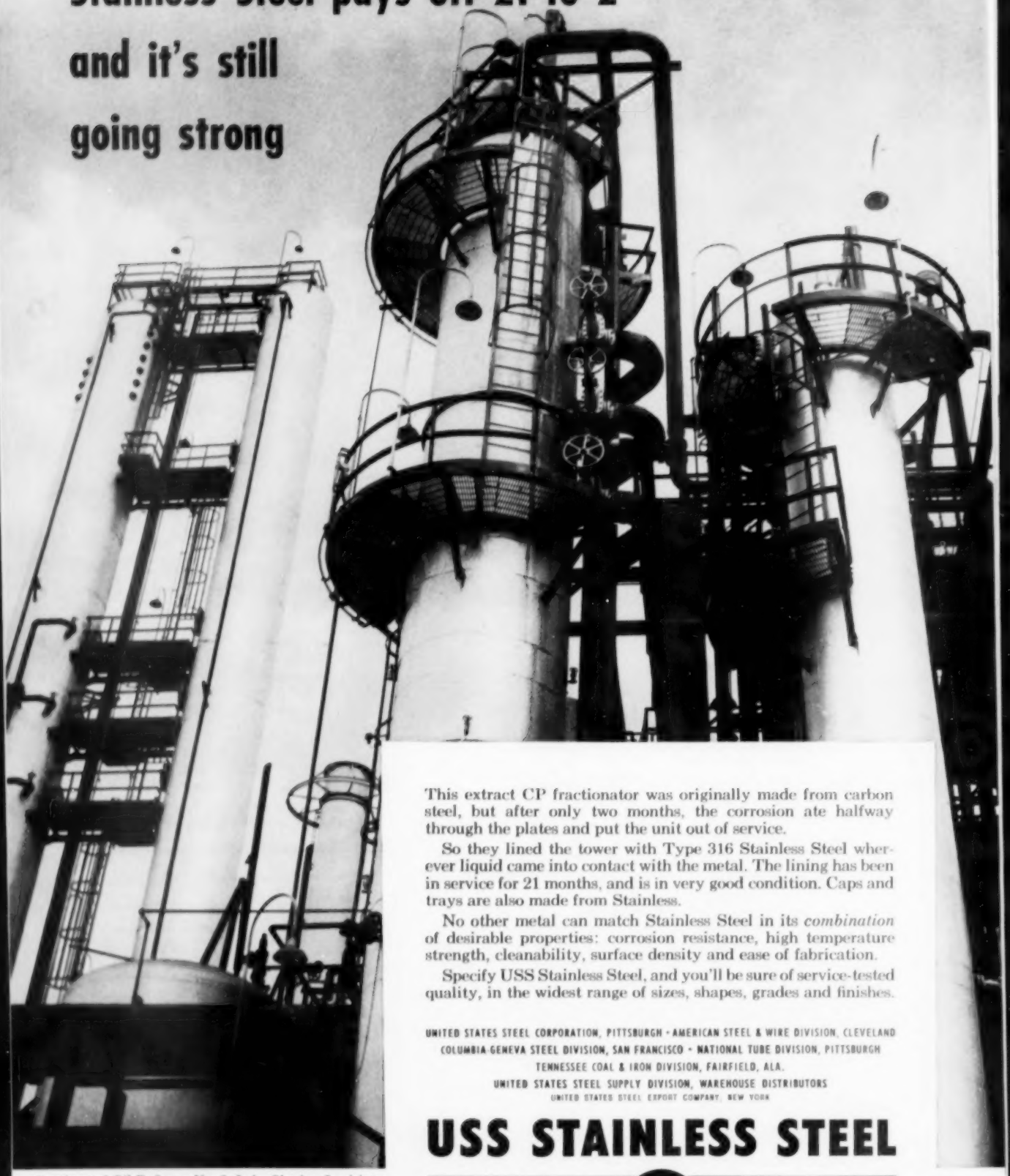
City _____ State _____

Saran Lined Pipe is Manufactured by The Dow Chemical Company, Midland, Michigan

you can depend on DOW PLASTICS

DOW

Stainless Steel pays off 21 to 2 and it's still going strong



Continental Oil Refinery No. 3, Lake Charles, Louisiana.

This extract CP fractionator was originally made from carbon steel, but after only two months, the corrosion ate halfway through the plates and put the unit out of service.

So they lined the tower with Type 316 Stainless Steel wherever liquid came into contact with the metal. The lining has been in service for 21 months, and is in very good condition. Caps and trays are also made from Stainless.

No other metal can match Stainless Steel in its *combination* of desirable properties: corrosion resistance, high temperature strength, cleanability, surface density and ease of fabrication.

Specify USS Stainless Steel, and you'll be sure of service-tested quality, in the widest range of sizes, shapes, grades and finishes.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

SHEETS • STRIP • PLATES • PIPE • TUBES • WIRE
BARS • BILLETS • SPECIAL SECTIONS

USS

SEE The United States Steel Hour. It's a full hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

Like a bucket with a hole in it . . .

THE FULL MEASURE OF "PEP"
WILL NOT STAY IN YOUR MOTOR FUEL
WITHOUT . . .

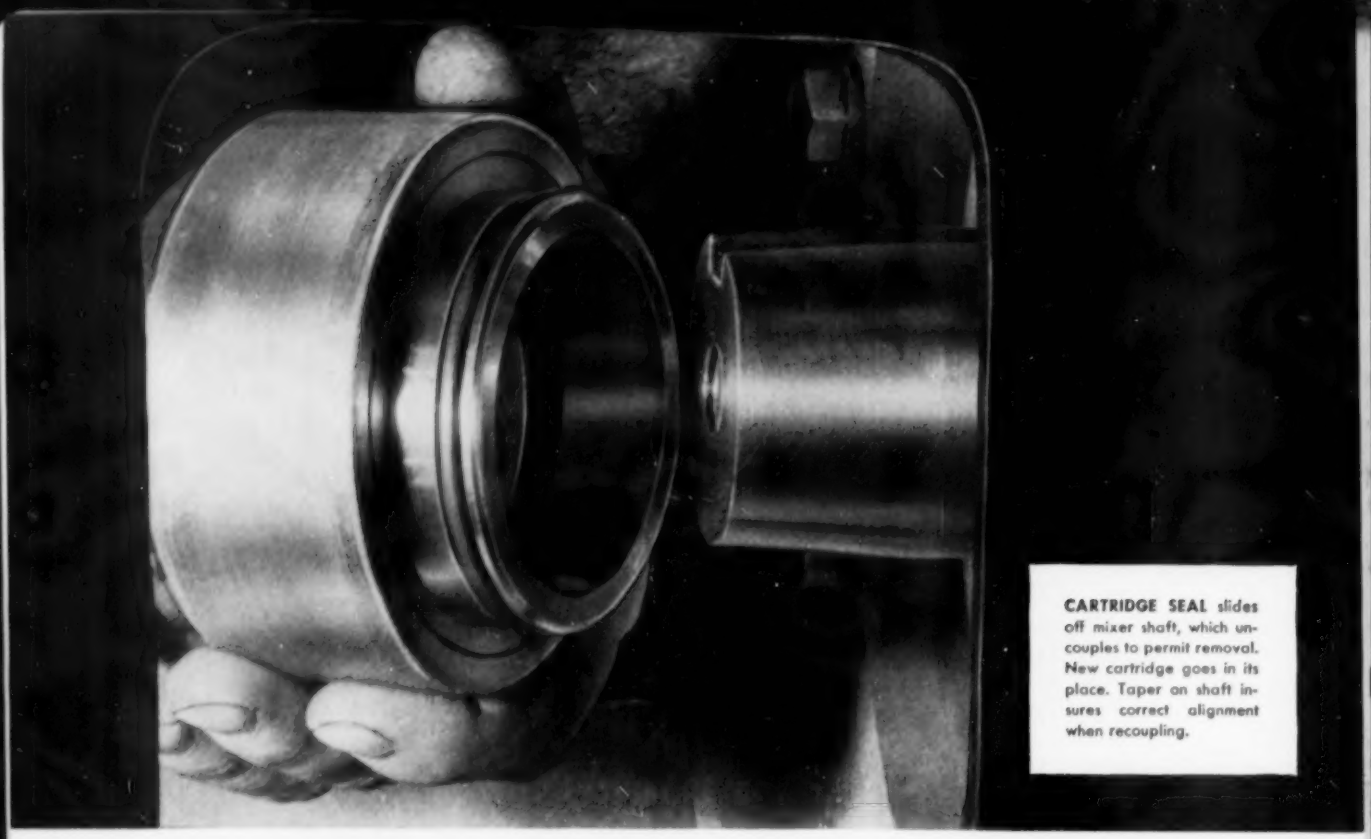
RETAINED VOLATILITY

Blend WARREN NATURAL GASOLINE with your present high quality motor fuel to give it superior performance after it reaches your customers' fuel tanks!

WARREN
PETROLEUM CORPORATION

TULSA, OKLAHOMA • Cable Addresses: STAVOLENE, WARREN

EXPORT TERMINALS: CORPUS CHRISTI, PORT ARTHUR, BAYTOWN, TEXAS CITY AND WARRENGAS, (HOUSTON) TEXAS; SAN PEDRO, CALIF.



CARTRIDGE SEAL slides off mixer shaft, which uncouples to permit removal. New cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

Cut mixer maintenance 60%
with this cartridge-type *rotary seal*

Stops leakage! Runs years without adjusting! Slides off for fast, easy replacement!

If you're mixing or blending in big tanks, here's the newest way to slash mechanical mixer upkeep as much as 60%.

For here at last is a rotary mechanical seal—optional on new LIGHTNIN Side Entering Mixers—that stops leakage around the tank, ends stuffing-box repacking and adjusting for good.

And for the first time ever on big-tank mixers, you can replace this seal in a jiffy if you ever have to! No need to dismantle or remove the mixer from the tank. No need to drain the tank. No special skill required!

Even under a full head of liquid in the tank, the seal-change job is so simple it takes only minutes. The mixer shaft retracts to seal the tank, then uncouples. The seal cartridge slides off in one piece. A new cartridge slides on; the mixer shaft automatically realigns itself when recoupled—and you're back in operation.

The LIGHTNIN seal cartridge is a complete unit assembly, easy to stock as a replacement, or quickly obtainable in all sizes and materials, for the simplest or most difficult operating conditions.

Already, many oil companies are using LIGHTNIN Seals—and saving many thousands of dollars per year. Your LIGHTNIN Mixer representative can give you the full story—show you how much *you* can save. Call him today—he's listed in your copy of Refinery Catalog. Or get the facts by mail: send the coupon for 8-page, fully illustrated bulletin.

Lightnin® Mixers

MIXCO fluid mixing specialists

Left: **NO STUFFING BOX** to repack or adjust. No leakage around the tank. When correctly applied, seal runs for years without adjustment. *Right:* **REPLACEMENT** is simple, even with tank full. Mixer shutoff closes like a valve to keep liquid in the tank while seal is being changed.

☐ ***Quick!*** **Send us the cost-cutting facts on LIGHTNIN Rotary Mechanical Seals—Bulletin B-111. We'd also like catalog information on these LIGHTNIN Mixers:**

- ☐ B-102 Top or bottom entering; turbine, paddle, and propeller types: 1 to 500 HP
- ☐ B-103 Top entering propeller types: ¼ to 3 HP
- ☐ B-104 Side entering: 1 to 25 HP
- ☐ B-108 Portable: ⅛ to 3 HP
- ☐ B-112 Laboratory and small-batch production types
- ☐ B-110 Condensed catalog showing all types
- ☐ B-107 Data sheet for figuring mixer requirements

Check, clip, and mail with your name, title, company address to:

MIXING EQUIPMENT Co., Inc., 131-e Mt. Read Blvd., Rochester 11, N.Y.

In Canada: Greey Mixing Equipment, Ltd., Toronto 10, Ont.

Petroleum Processing

MAY 1956

ELEVEN TECHNOLOGISTS
and a recorder bring
you up to date with . . .

This Month's Technical Tips on . . .

Catalytic Cracking Problems

Do you need answers to questions like these?

- CATALYTIC CRACKING—Barrel for barrel, how much additional fresh gas oil could be charged on a unit operating at coke burning capacity by withdrawal of slurry?
- CATALYTIC CRACKING—What are the detrimental effects when spray water is added above the catalyst bed in the regenerator to reduce regenerator temperature?
- CATALYTIC REFORMING—What methods can be used to correct the fouling of furnace burners when utilizing the off-gas from catalytic reforming units?

These are just samples. Questions and answers on this month's subject, catalytic cracking, are given on the following pages. In future issues we'll offer dozens of other useful tips on processing problems.

Part 1—Catalytic Cracking:

? On a barrel-for-barrel basis, how much additional fresh gas oil could be charged to a unit operating at coke burning capacity by the withdrawal of slurry?

Clarke

Clarke: A ball-park figure would seem to be about 3 bbl per bbl. Beyond that, however, I think we might state a range of from two to eight or so. Actually, I have seen some determinations that would indicate as high as 15. But that is rather extreme. In general, I think we might look at that question on this basis. Let's say there's 5% carbon laydown from your feed. We have seen laydowns of practically pound per pound of converted products on some slurries, depending of course on the boiling range and the cut. These figures would indicate a theoretical ratio of about 10. That is about 5 lb for a given volume of feed and 50 lbs or so for an equivalent volume of slurry.

I think you would want to make an actual determina-

tion in any case to tie the figure down closer to whatever conditions and feedstocks you happen to be running at the time.

? When operating at coke burning capacity and with fresh feed preheat of 350 to 400° F., could you gain a significant amount of capacity at a given conversion, or additional conversion at a given capacity, by preheating the feed to 700 to 750° F?

Clarke: If we are operating a unit at its carbon burning capacity with a feed preheat of 350 to 400°F. and the unit is in heat balance—as we may naturally assume—then raising the preheat up to the region of 700 to 750° is adding heat where it is not required, because the unit is in heat balance.

The question is, what would happen? There are a good many paths we can take from that particular condition. The one I have taken as an answer to the question is that we hold reactor temperature the same. Under this condition we will then reduce catalyst circulation because the reactor won't need as much heat to maintain that temperature level with the increased preheat. That would take less heat out of the regenerator, so the regenerator temperature would rise.

With a decrease in catalyst circulation, we would be carrying less strippable hydrocarbons to the regenerator. As a result, less air would be used in burning unstripped hydrocarbon. That would tend to improve our oxygen utilization and we would wind up dropping below the carbon burning capacity at which we were previously operating. That in turn would permit an increase in feed.

We didn't see these questions, of course, until about an hour or so ago, and that did not permit time to make any long winded calculations to give a specific numerical answer to the question. I think, for present purposes, about all we can do is just indicate a directional answer. And the answer to the question is yes.

? What methods have been used to prevent fouling on the charge stock side of charge stock-to-circulating oil heat exchangers. Has inhibitor addition to, or oxygen removal from, the feed stocks proved effective?

Clarke: I believe it is generally agreed that fouling is caused mainly by oxygenated compounds which tend to foul in the range of 350 to 450°F. Speaking for Esso, as far as I know we haven't tried any inhibitors, but we have taken a step which has given some reduction in the fouling, and that is to blanket the feed tanks.

Others may have experience on inhibitors or other practices, but speaking from our own experience, that is all we have done. It has not eliminated the problem; it has only alleviated it slightly. Of course, we are solving this problem to some extent by—you might say, going around it—and that is through periodic cleaning of our feed exchangers, as necessary during the run.

Some of our refineries are using chemical means, and others are using mechanical means. We do not have one single practice. So I would say in summary that we are living with the problem, and it's not causing any undue difficulty.

? With regard to catalyst, has anyone converted to 100% high alumina, and if so, how has this new catalyst affected charge rate, yields, performance, and catalyst losses? With regard to catalyst losses, has anyone been successful in reducing losses without shutting down his unit?

Clarke: With regard to the use of the high alumina—the 25% alumina catalyst which is being advertised quite extensively these days—we have not used it in any of our plants, but we have kept an eye on it.

Some time ago, specifically back around 1946 or 1947, we did try—on an experimental basis—a run on 20% alumina catalyst. I should say that it was not manufactured by the same process that is now producing the 25% alumina catalyst, so there could be a difference in results because of this. Our experiments at that time with 20% alumina catalyst did not indicate that it had any advantage at all. So, I guess as a natural consequence of that, we have perhaps been a little reluctant to try out the current 25% alumina catalyst.

On the other hand, we have studied the results of trials other refiners have made. The data we have seen so far have not made us believe that we should jump in and give it a trial.

I would like to qualify what I have said as strictly a Jersey opinion. Maybe we haven't seen all the facts and I wouldn't want to say anything that would stand in the way of somebody trying it. There are certainly some attractive claims being made for the high alumina catalyst. This doesn't mean we will close our eyes to it in the future. We may get into the act sooner or later. We do know that in several of the applications, for various reasons, the trial has been concluded by going back to the previous catalyst. We know of no one who has tried it and stayed with it. That may be a limited picture—it probably is—it's just what we've seen while looking around.

? There's a supplemental part to that question with regard to catalyst losses. Has anyone been successful in reducing losses without shutting down his unit?

Clarke: Well, I am not quite sure how to interpret the question, but I assume you mean the running loss. We, of course, have had various abnormal conditions develop on the run, which I'm sure everyone has. Usually they have been the type of thing that has gotten worse and worse, finally hitting 25 to 40 tons per day—or something like that—and we've had to bring the unit down.

On the other hand, when our losses start to go up like that, we try to determine what the possible cause is and, also, if anything can be done to get things back in line without bringing the unit down. Naturally, we don't like to bring the unit down; nobody does. In a few situations we have been able to bring the losses down.

We have used splash plates, seal pots, and most recently trickle valves on our cyclone dip legs. We have a new means of shrouding the trickle valves which has helped a lot in their operation and in keeping them from damage on the run. When run losses increase rapidly, we usually look first for cyclone dip-leg plugging or other abnormalities in that part of the circuit, and we then do what we can to try to get normal operation re-established, or the restriction broken down while the unit is on. A

Where this Information Came From

STARTING with this article, the editors of PETROLEUM PROCESSING are pleased to present—for the fourth consecutive year—a series of features bringing you questions and answers to processing problems.

As in the past, these articles will cover all major phases of plant operation. In this issue the subject is catalytic cracking. Catalytic reforming, octane improvement, coking, treating, and miscellaneous topics will be covered later.

This wealth of helpful technical information has come from a recorded transcript of the all-day question-and-answer session at the El Dorado, Ark., regional meeting of the Western Petroleum Refiners Ass'n, Oct. 21, 1955. This has been a popular annual feature of this particular meeting ever since 1950. It has been through the cooperation of the WPRA that PETROLEUM PROCESSING has been able each year to help distribute this information to operators and engineers throughout the petroleum processing industries.

A panel of 10 experienced petroleum processing men replied to a series of prepared questions and then discussed and answered more questions from the floor. The group of five refinery men and five engineering men was directed and moderated by Harry K. Wheeler, Pan-Am Southern Corp., El Dorado.

The refiners were: N. S. Banta, Pure Oil Co., Nederland, Tex.; E. A. Heike, Premier Oil Refining Co., Ft. Worth, Tex.; L. K. Buchanan, Bell Oil & Gas Co., Ardmore, Okla.; M. S. Moody, Lion Oil Co., El Dorado; and O. A. Fuchs, Pan-Am Southern Corp., El Dorado.

The engineering panel: R. R. Maddox, Blaw-Knox Engrg. Co., Philadelphia, Pa.; J. S. Clarke, Esso Research & Engrg. Co., Linden, N. J.; D. F. Ferguson, The Refinery Engrg. Co., Tulsa, Okla.; J. F. Walter, Universal Oil Products Co., Des Plaines, Ill.; and D. E. Womeldorph, Houdry Process Corp., Philadelphia, Pa.

---

few times we have been able to do that by using the air blast connections in the dip legs.

We have broken dip legs, overflow wells, and all that sort of thing. Obviously, there is no way to repair a broken dip-leg or a major mechanical breakdown inside the vessel during the run. And in all situations, of course we had to come down in order to make appropriate repairs.

? Is anyone employing an elutriator, and if so, what are its benefits?

Clarke: In our panel pre-meeting discussion of these questions, we went off on two tangents on this one. I had never heard, until today, of anyone using an elutriator on a cat unit. But I find that Lion Oil is using one, and that it is accomplishing the purpose. Evidently the heavy material which is drawn off the bottom of the elutriator is below the addition rate of fresh catalyst required to maintain desired activity. Consequently, there would certainly be no objections, from our standpoint, of using such a device. However, speaking for my own company, which happened to develop this particular type of unit (it is one of our Model IV's), our design approach is in a different direction. We provide a so-called steam jet device whose purpose is to attrite the catalyst and break up the larger particles. We have it in all of our own plants, both Model IV and earlier, and it goes into licensees' plants.

Now as far as I know, most of our licensees are using these attritors and find them quite satisfactory. There have been comments from those who were not previously familiar with the attritor to the effect that they shot a lot of cat out of the stack. Well, that is quite true. If you are going to break up the bed catalyst, you are certainly going to make fines, and a certain amount of these fines are naturally going to go up the stack.

As a result, therefore, using the attritor will make your stack a little heavier either on a continuous or an intermittent basis. On the other hand, it is a very effective means of maintaining the desired particle size distribution in the bed.

The only precaution in the use of the attritor is that you can attrite the catalyst only so much before your stack losses exceed the necessary replacement rate. We have demonstrated in all of our units that a properly operated attritor will maintain the desired catalyst distribution without excessive losses or exceeding the cat makeup rate for activity.

? What are the detrimental effects when spray water is added above the catalyst bed in regenerators to reduce regenerator temperature?

Clarke: I think we at Jersey have perhaps lost sight of the real across-the-board picture because we have been concentrating recently on our Model IV units which operate under totally different conditions from the earlier units. Specifically, our bed velocities run well above 2½ fps, at which velocity there is considerable entrainment of catalyst. Most of that catalyst, of course, is knocked out in the cyclone and returned to the bed. If we were to use spray water in the dilute phase of a high entrainment unit, such as the Model IV, we would have to use a lot of water because we've got to cool both the catalyst—a high quantity of catalyst is carried up—and the gas. Dilute-phase water in the Model IV usually sends the bed temperature into a slump. In contrast to the earlier low velocity units—1.2 or as low as 1.0—most of the water you inject will cool the gas and very little of the catalyst.

I just wanted to bring out that point first, to distinguish between the so called Model IV and the pre-Model IV conditions. I assume that this question is in regard to the lower velocity units. There seemed to be a little divergence of opinion here in our earlier discussion of this question. Specifically, one source felt that it would be damaging to cat activity. I didn't think it would be at lower entrainment rates.

However, I think it can be resolved completely as follows: all hands agree that probably the worst source of damage or detriment would be the contaminants that are in the water. And we can eliminate them almost exclusively by using condensate rather than treated water, or water from another source. We people from Jersey use nothing but condensate in our sprays.

However—speaking again purely from Jersey experi-

Topics discussed here are:

- **Cold pressure drop**
- **Exchanger fouling**
- **Catalyst attrition**
- **Inhibitor injection**

ence—our practice or approach to the problem has been this: operate the unit so as to minimize the need for using dilute phase water. That can be done by keeping the bed at 1100°F maximum, preferably below it, and keeping oxygen break-through to absolute minimum. Our Model IV units do not use dilute phase water at all when operating at design velocities. However, dilute phase sprays are provided, but are employed for emergency or very local vessel conditions only.

We feel though—and this finally is getting around to answering the question—that by operating to use minimum water, the amount injected in our operations has not been enough to have a noticeable detrimental effect on the catalyst. However, we fully agree with the school of thought that large quantities of water can result in a detrimental effect on the catalyst activity.

One of the side issues here is that in order to utilize the sprays to best advantage, the efficiency of atomization must be maintained. In that regard, our practice, which we learned the hard way, is to make all sprays removable so that they can be serviced at any time on the run. We also have periodic withdrawal and inspection of the sprays to insure proper atomization.

Now, I personally have seen these spray heads go out in as little as about nine days of plant operation. I am talking about the spray head that is made of 25-20 alloy. The damage was caused by the combination of erosion and possibly some corrosion caused by the spray head being positioned too far beyond the vessel wall.

A special experience I would like to mention in closing with this question is one we ran into at our Billings, Mont., unit.

We usually put spray shields around our dip legs so that the spray water would not get on and chill the dip legs, and in this particular instance we were a little low in distance between our spray and spray shield. Now it was very easy to see in hindsight what had happened, but when we first tackled the problem the answer was not very obvious. So giving the hindsight picture, it turned out that our spray water was plating out on the spray shield and in the presence of some H_2S plus the catalyst, we were cementing up the catalyst, forming big agglomerates—some of them were quite big—which were then dropping down into the bed, breaking up and then being carried over into the reactor, where they plugged up the grid holes. As a result of something which started at the regenerator spray shields, we finally brought the unit down with a 16 psi pressure drop across the reactor grid!

Wheeler

Wheeler: Thanks a lot, Jim. We're glad to hear that somebody else had this problem of cold pressure drop. Don Womeldorph, can you give us an answer to the next question?

? Does anyone have a reference or a method for predicting the yield and characteristics of the heavier than gasoline portion of the TCC reactor effluent for various operating conditions, and for different type feed stocks at constant operating conditions?

Womeldorph

Womeldorph: I don't think that I can answer that specific question, although I have a reference that relates to predicting product distribution and yield. The reference that I refer to is one in *Chemical Engineering Progress*, February, 1951, entitled, "Moving Bed Recycle Catalytic Cracking Correlation." This paper presents a correlation prepared by Houdry Process Corp. from a large number of pilot plant runs. Run-around charts are included in the reference for various operating conditions.

These charts require pilot plant runs—possibly two runs—to establish a feed stock reference line. Once you have a reference line you can get the product distribution and yield of your different components.

Now the question here is specifically on the heavier-than-gasoline portion. This reference is not too complete on this. However, it gives some information on the gas oil yield that you might expect.

The paper states that the gas oil API gravity and aniline point decrease with an increase in conversion, and are independent of the recycle ratio and cracking temperature. It shows that you have a marked decrease in the 90% evaporation point as you go up in conversion, or that your increased conversion is being obtained by cracking the heavier portion of the gas oil fraction. It also indicates that recycle ratio has no particular influence on the boiling range of these materials, but that temperature appears to slightly affect the light gas oil. I offer that reference for what it's worth, but I don't think it completely answers the question.

? Wheeler: Does anybody else on the panel have any comments to make on catalytic cracking?

Banta

Banta: I would like to add a comment to the question about fouled exchangers. At our Toledo refinery we've utilized a Nalco 161 to take care of the difficulty experienced through the fouling of exchangers. And apparently it worked very well at that plant. The usage amounts to around 10 to 12 ppm, and is introduced into the feed ahead of the exchanges by means of a conventional proportioning pump.

I might also add some comments to the question on 25% alumina catalyst. Our plant has switched to 25% alumina with the unit start-up beginning in May of this year. Our current concentration of alumina is around 21.8%.

As a result of that change, we reduced our catalyst make-up possibly a half a ton per day. As all you Fluid unit men know, it's difficult to come up with a good firm

figure on catalyst make-up. As a result, a further advantage of that addition would appear to be that our B-B cut increased from 15% up to 20%. So we do get quite an appreciable change in butylenes in our B-B cut production. That appears to have been as a result of a decrease of what we call our light cracked distillate production. In our particular unit we are cycling the heavier recycle. We have noticed a marked increase in catalyst activity.

One other thing has been interesting that was mentioned in the panel review this morning. Although we do have a higher activity, laboratory-wise, it doesn't appear to give us that same increase on a process plant. It would be interesting to hear if anybody else has a comment on that particular item.

Fuchs

Fuchs: I would like to give our experience with high alumina catalyst. We have a UOP-design unit with the regenerator on bottom and the reactor on top. The unit was designed for a 10,000 b/d reactor charge.

We were having difficulty with cat activity maintenance in 1954. We were adding 3 to 3½ tons to make up activity, discarding 2 to 2½ tons with about 1 ton going out the stack. We started adding catalyst containing 25% alumina in October of that year. After we had 77% high alumina in the unit, a comparison with low alumina operation showed that we had cut our cat addition from 3 to 3½ tons to 1 to 1½ tons. No operating difficulties were observed and catalyst addition was just sufficient to make up losses.

We raised the UOP weight-activity from an average of 22 to 26 with a lower catalyst addition rate.

We received a benefit in regeneration as a result of decreased CO_2 to CO ratio. This was lowered from about 1.12 to 1.02. We also decreased our carbon on the regenerated catalyst from about 0.8 to about 0.5. We feel that we benefited greatly from the high alumina in terms of the money saved in cat addition, and the extra coke burning made available through the decrease of CO_2 to CO ratio. We are still using high alumina in this unit.

Wheeler: Any more comments from the panel? Don?

Womeldorph: I have a comment that I would like to make on fouled exchangers. We have found both cat reforming stocks and cat cracking stocks dissolve oxygen quite readily. We found that gas-stripping the material also gives a fair solution to the problem of dissolved oxygen. As indicated before on the gas blanketing, I don't think it gives complete protection, but it certainly helps. Another way of eliminating the oxygen would be to charge your material directly from another unit without intermediate storage.

Clarke: I might elaborate on that last point you mentioned. In our combination units, where the cat feed never sees the daylight, we don't have the problem at all. I think our experience in stripping improves things on virgin stocks. On cracked stocks, however, this cold stripping won't make any appreciable improvement.

Womeldorph: I was thinking primarily about virgin stocks —naphthas and gas oils.

Moody: On the question of attrition; I would like to say we also, have an attritor that we have tried, but the selective removing of the catalyst by an elutriator has been much more satisfactory for circulation—particularly in controlling our particle size.

Moody

Wheeler: Before we open it to the floor, Oscar, do you have another point?

? Fuchs: I would like to ask Norm Banta a question about the economics of inhibitor injection. Do you have valves on your exchangers so that you may clean them during the run?

Banta: No, on this particular unit, there are no provisions for cleaning them during the run.

Fuchs: We have investigated the economics and found that cleaning the exchangers every three months is cheaper than adding the inhibitor.

? From floor; Alexander (Pan-Am): Is anybody using these "micro-spheres" for blanketing their cat cracker feed tanks to prevent oxygen from getting into the feed?

Wheeler: Does anybody on the panel have any comments on that? Has anybody in the audience tried that? Apparently not. Mr. Alexander, you have asked the $64,000 question.

? From floor; Forter (Cities Service Refining): What do you use as a basis for the quantity of slurry withdrawn? Carbon resid, or gravity, do you have a rule-of-thumb, or what else?

Clarke: I'm afraid this isn't the kind of answer you are looking for, but we pitch it on cat content only. Now, I might explain that by saying our trend these days and for the past ten years, has been to minimize catalyst carryover in the reactor, specifically aimed at minimizing necessary slurry recycle.

Forter: Do you have a slurry settler?

Clarke: No.

Forter: That would make a difference?

Clarke: Yes sir.

IN JUNE: CATALYTIC REFORMING PROBLEMS

Caught at San Antonio

Petroleum Processing's cameraman snaps refiners at WPRA's 44th annual meeting

WHEN the Western Petroleum Refiners' Ass'n held its 44th annual meeting in San Antonio, March 19-21, Reid Brazell, president, Leonard Refineries, Inc., Alma, Mich., was re-elected WPRA president for his second one-year term.

Also re-elected were these four vice-presidents: Bruce K. Brown, president, Pan-Am Southern Corp., New Orleans, La.; Harry J. Kennedy, vice president, Continental Oil Co., Houston, Tex.; F. L. Martin, president, Suntide Refining Co., Corpus Christi, Tex.; and J. W. Vaiden, vice president for manufacturing, Skelly Oil Co., Tulsa, Okla.

Three new directors were named. They are George J. Peterschmidt, executive vice president and treasurr, El Dorado Refining Co., El Dorado, Kans.; W. H. Cravens, vice president & manager of refining, Cities Service Oil Co., Bartlesville, Okla.; and Henry J. Muller, Socony Mobil Oil Co., Kansas City, Mo.

San Antonio will again be the location for the 1957 convention. No dates have yet been set.

R. S. Randolph, Dist. Mgr., General American Transportation Co., Tulsa. **C. W. Guy,** V.P. & Treas., Texas Natural Gas Corp., Tulsa

H. E. Cottrell, Account Representative, Ethyl Corp., Dallas. **V. B. Chance,** President, Atlas Process Company, Shreveport

T. J. Sullivan, Senior V.P., Gulf Oil Corp., Pittsburgh. **B. H. Barnes,** V.P., Mfg. Dept., Gulf Oil Corp., Pittsburgh. **K. G. Mackenzie,** Kenneth G. Mackenzie Associates, Westport, Conn.

W. F. Sims, Refinery Consultant, Blaw-Knox Co., Tulsa. **H. R. Jarvis,** District Mgr., Petreco Div., Petrolite Corp., Ft. Worth. **Bruce Jones,** Asst. to Pres., McMurrey Refining Co., Tyler, Texas

J. E. McCarthy, Sales Engr., Clark Bros. Co., Tulsa. **M. O. Kilpatrick,** Ch. Proc. Engr. Gasoline Dept., Phillips Petroleum Co., Bartlesville. **E. R. Jones,** Ref. Supt., Derby Refining Co., Wichita

L. L. Huxtable, sales representative, Ethyl Corp., Tulsa, Okla. **Keith M. Tiernan,** refinery supt., Wilcox Oil Co., Bristol, Okla.

J. W. Hyde, Tech. Rep., British Petroleum Co., N.Y. **W. S. Nordburg,** Asst. to Mgr., Development and Patent Dept., Standard Oil Co. (Ind.), Chicago

Robert Phillips, Mgr., Howe-Baker Corp., Houston. **T. W. Warren,** Director of Refinery Technology, Ethyl Corp., Detroit

Ray Granlund, V.P.-Sales, Eastern States Petroleum Co., Houston. **W. W. Fetter,** Mgr., Texas City Refining Co., Texas City

K. E. Agee, Mgr., Engrg. & Purch., Texas City Refining Co., Texas City. **C. H. Barre,** Ch. Chem., Republic Oil Co., Texas City

Tom Risk, executive engineer, Catalytic Construction Co., Philadelphia. **Ted Littlefield,** western regional manager, Ethyl Corp., Los Angeles.

Neal Prichard, V.P. Mfg., Anderson Prichard Oil Corp., Oklahoma City. **John Benedict,** Sales Engr., Davison Chemical Co., Houston

R. G. Arner, Asst. to V.P., Sinclair Refining Co., Chicago. **J. D. Seifer,** Refinery Manager, Sinclair Refining Co., Houston

D. G. Morgan, Director of R & D(D-X Sunray Co., Tulsa. **G. E. Wynn,** Exec. vice-president, Mfg., D-X Sunray Co., Tulsa

HUGE, UNUSUALLY DESIGNED warehouse at Gulf's Port Arthur, Tex., refinery spearheads attack as . . .

Gulf Beats a Bottleneck

A WATER TRAFFIC JAM was causing trouble at Gulf Oil Corp.'s 245,000 b/d refinery at Port Arthur, Tex. Gulf set out to unsnarl it in 1953, and ended up, early this year, with a package terminal and warehouse that's among the biggest and most up-to-date in the country.

The enormous steel-and-concrete structure covers a lot of space—7.4 acres. And most important, it keeps the barge and tanker traffic moving.

Gulf had to analyze and solve two basic problems before the traffic jam could be unraveled:

- How to set up a waterfront loading scheme that would cut delays in ship movements and eliminate the danger of tanker-barge collisions.
- How to create a smooth-working warehousing system that would backstop operations at the waterfront.

Here's the way Gulf attacked and whipped these twin problems.

Waterfront Efficiency

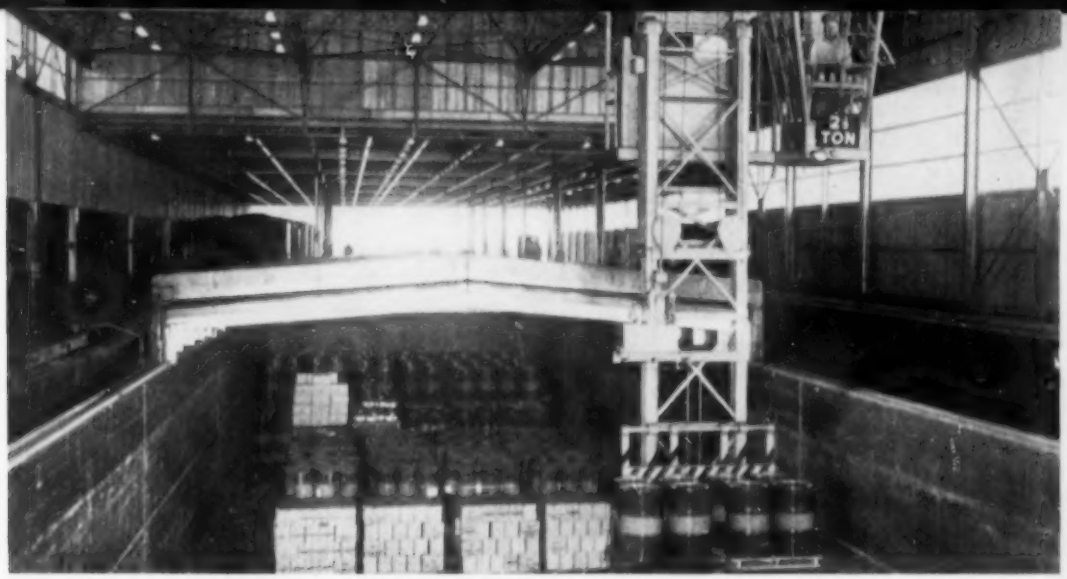
Half the product moving out of Port Arthur goes by water—the other half splits evenly between trucks, vans and railroads. Under Gulf's old loading scheme, tankers and barges used the same dock for liquid and dry cargos. The bigger tankers were sometimes delayed until barges could be loaded and moved out of the way. There was ever-present danger of collision among the big tankers and clumsy barges. By 1953, congestion of river and ocean-going traffic was acute.

Gulf studied the problem, got the answer late in the year. In November the company decided to construct separate dry cargo loading facilities for barges, rail cars, and motor vans. It picked a location with a barge slip, on property already owned by Gulf.

Another feature is a battery-charging station, equipped to charge 16 batteries at a time for the plant's electrically driven fork-lift trucks, towing tractors, floor sweeper and scooters.

The warehouse is a complete package plant, handling every product Gulf markets. Roughly 70% of the 240,000 sq ft of undercover space is storage. The rest is for loading and aisles.

Inventory Speeder — Products are stored on pallets. Plastic tape, laid along the floor, indicates by color how high pallets should be stacked in any particular section. To take inventory, Gulf uses what it calls the "negative" method. the inventory taker has a master floor plan, and moves along the aisles. The sections are coded alphabetically, aisles and spots numerically. The notation A74 on the inventory taker's chart would mean section A, aisle 7, spot 4. The plastic tape tells the checker how high the pallets should be stacked. He takes inventory by noting how many are gone, not how many are left.



COMPANY DESIGNED, 2-ton crane loads barge in slip adjoining warehouse

BARGE AREA is far enough away from tanker loading dock to minimize collision danger

There is considerable rotation of supplies, aimed at getting slow-moving items toward the back, fast-moving ones up front.

Safety Area—Gulf went all out to provide a special area for storing low-flash petroleum products that would be as fireproof as possible. The area has special, electrically controlled doors, reinforced by heavy fire doors, to insure that flames from a possible fire will not spread to other areas. Through ventilators on the roof, air in the low-flash area is constantly changed to keep any escaping fumes from building up.

Thermostats are located at high and low levels throughout the room to set off a "chain reaction" if room temperature passes a certain limit. Everything happens almost simultaneously. An alarm system is set off, then the sprinkler system goes into operation at the rate of 4,000 gpm. The huge fire doors close, and all ventilation is stopped.

Who Did It—Gulf hasn't said what the new building cost. The Noble Co. of Oakland, Calif., designed and built the two special fork-lift cranes the company needed, in collaboration with Gulf personnel. Stone and Pitts of Beaumont designed the building. H. K. Ferguson Co. was the general contractor.

The area was near the old docks, but far enough away to solve the traffic trouble.

Construction Kinks—The going, at first, was tough. The new location was on mushy ground, and 8,000 wooden pilings were needed to provide a good foundation. Some pilings had to be capped with 16 ft. of concrete.

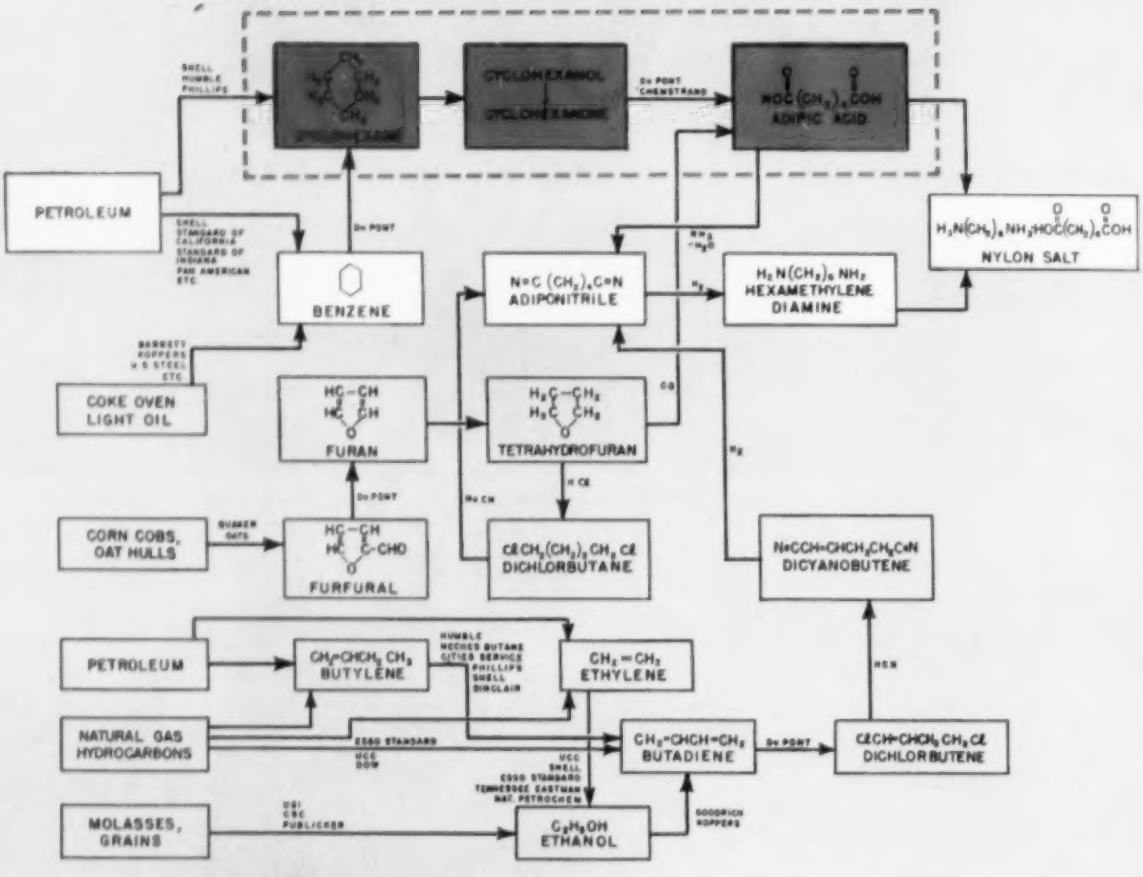
From start to finsh, the job took just under a year. The completed warehouse can load four small barges, 35 box cars, and 10 trailer trucks simultaneously. Tankers continue to load at the old docks, unimpeded by smaller vessels.

Loading preparations are handled by electrically-operated lift trucks and towing tractors. Small motor scooters carry workers from point to point in the warehouse. Because the entire area, including barge slip and mooring facilities, is covered over, bad weather is no problem. Actual loading is done by a special, Gulf-designed crane. These cranes, built to maneuver in very tight quarters, can deliver up to two tons of packaged cargo on each trip into the hold of a barge. They can make deliveries while working 15 ft below deck level.

Streamlined Warehousing

A smooth-running, safety-conscious warehouse supports the waterfront operation.

Even Loads—Under the old system, employes often had erratic work schedules. There were problems in storing low-turnover items; space was so tight that only fast-moving products could be stored. Now there is room to store over 800 different items, fast and slow-moving. Employes work a steadier pace, don't have to speed up or put in overtime as they did when products weren't available at peak loading times.



KEY TO IMPORTANCE OF ADIPIC ACID is shown here in its use in nylon

Why Adipic Acid Is Important Now

By PETER W. SHERWOOD
Chemical Engineer
White Plains, N.Y.

ADIPIC ACID is an important material that's growing more important. As the chart shows, it's one of nylon's principal intermediates. In theory, 65 lb of it is used to make every 100 lb of nylon-66. And much of hexamethylene diamine, another of nylon's intermediates, is also made from adipic—via adiponitrile.

Other markets are now widening. Biggest of these is the plasticizer industry. The U.S. Tariff Commission reports that 1954 production of all adipate plasticizers reached 7-million lb. Of this, di(2-ethyl hexyl) adipate accounted for 2.7-million lb, a sizable market in itself. In 1950, total adipate plasticizer production was only 6-million lb.

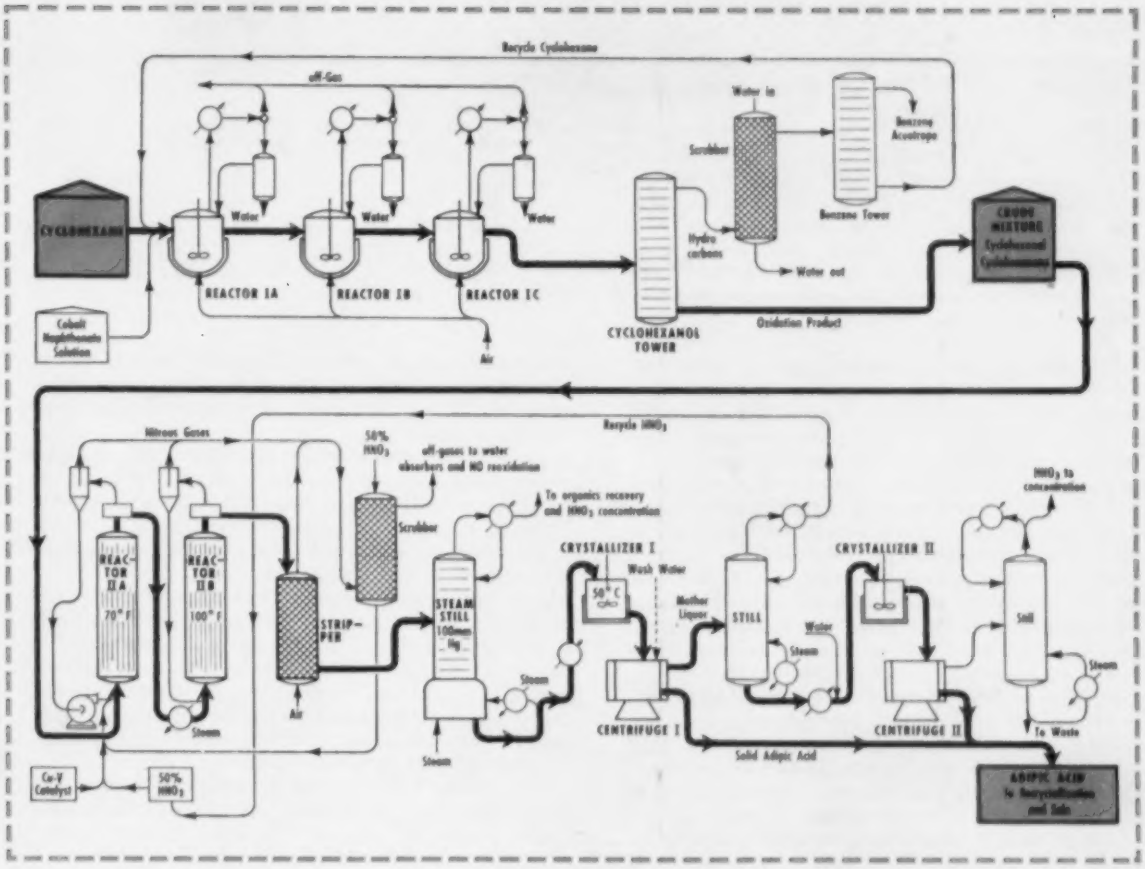
Other promising, though still unimportant outlets are: certain polyesters and alkyd resins, "Vulcollan," a type of rubber still in development, and related polyurethane resins.

The synthetic fiber industry, however, is by far adipic acid's largest and fastest growing market. Production of nylon-66 reached 200-million lb in 1955, up from 24-million lb in 1945, and 100-million lb in 1950.

Cyclohexane is the basic raw material for adipic acid production today. Changing economic conditions have almost forced benzene, the dominant raw material in the late 1940's, out of the domestic picture. However, benzene is still the prime material in England, while in Germany, benzene is used with natural phenol, and furfural.

Reliance on benzene as a source requires either hydrogenation to cyclohexane as first conversion step or conversion of benzene to phenol, which may be readily hydrogenated to cyclohexanol.

In the U.S., developments of the past half-decade have made it no longer economical to produce cyclohexane from benzene. Instead, the materials flow has been reversed and benzene is being synthesized on a significant scale from petroleum derived cyclohexane (and methyl cyclopentane). And for adipic acid production via cyclohexanol, cyclohexane is now *the* basic starting material.



THE ROUTE FROM PETROLEUM TO ADIPIC ACID is shown in this schematic flow chart

and How It's Made from Cyclohexane

TWO fundamentally different routes lead from cyclohexane to adipic acid: Direct single-step oxidation, and two-step oxidation in which cyclohexanol and cyclohexanone are obtained as (crude) intermediates. Only the second method has so far attained commercial stature, but the attraction of a single-stage manufacturing method has provided incentive for considerable developmental work along this line.

The commercially important method of adipic acid production is the two-stage route. The first step in this synthesis is the conversion of cyclohexane to cyclohexanol and cyclohexanone. Air serves as oxidizing agent.

The reaction is carried out in the liquid phase, i.e., by passing air through cyclohexane. The temperature range is 120-150°C. To maintain the liquid phase, a system pressure between 3.5 to 5 atmospheres is thus called for.

Non-catalytic operation is feasible above, say 140-145°C. At such conditions, the reaction is autocatalytic. An incubation period is thus observed which may be eliminated by introduction of suitable peroxides, some

How the Adipic Acid and Adiponitrile Producers Line Up in the United States

Manufacturer and plant location	Basic raw material	
	Adipic Acid	Adiponitrile
Chemstrand—Pensacola, Fla.	Cyclohexane	Cyclohexane via adipic acid
Du Pont—Belle, W. Va.	Benzene and cyclohexane	Via adipic acid
Du Pont—Orange, Texas		
Du Pont—Niagara Falls, N.Y.	———	Furfuraldehyde Butadiene
Du Pont—Victoria, Texas		
National Aniline—Hopewell, La.	Cyclohexane	———
Monsanto Chemical—Luling, La. (under construction)	Cyclohexane	———

Table 1—Air Oxidation of Cyclohexane in Pilot Plant

Cyclohexane kg.	Catalyst, kg. (cobalt ion)	Temp. °C	Pressure atm.	Time hrs.	Cyclohexane used, kg.	Oxidation product, kg.	Adipic acid* from 100 gm. of— Oxidation prod.	Cyclohexane
260	0.5	120	4.2	8	38.3	43.3	97.7	110
270	0.5	146	5-6	9	41.7	43.3	91	90.5
252	0.25	147	5-6	6	38.1	40.5	97	103
250	none	147	5-6	7	35.6	43.3	103	125.5

* Adipic acid yield was determined by laboratory-scale nitric acid oxidation of the cyclohexane oxidation product.

cyclohexanone, or by recirculating part of a previous charge.

In the course of non-catalytic conversion, peroxides accumulate in the system up to a maximum of 3.5% (depending on temperature and surface conditions). Yield of cyclohexanol and cyclohexanone in non-catalytic conversion can be made to equal the results in catalytic operation but, because of the relatively high temperatures, higher pressures are called for.

A suitable catalyst gives good results at 120-130°C. Of the variety of catalysts mentioned in the patent literature, cobalt naphthenate is the best for which data is known.

Even in the presence of a catalyst, the reaction has a very long incubation period. This may be overcome by the use of an initiator. A number of organic peroxides, per-acids and ketones can serve usefully in this function. Cyclohexanone, itself one of the reaction products, may be used as initiator without the introduction of impurities.

The oxidation product is primarily a mixture of cyclohexanol and cyclohexanone. No method is known to carry out the reaction to the substantial exclusion of one or the other of these products. Therefore, if cyclohexanol is the desired product, it is necessary to reduce contained cyclohexanone by catalytic hydrogenation. The pure ketone must be produced by oxidation of the cyclohexanol.

However, for the production of adipic acid, which is the principal purpose of most cyclohexane oxidation, the crude mixture of cyclohexanol and cyclohexanone serves as a satisfactory starting point, so that isolation of either chemical is not required.

The original process for the partial oxidation of cyclohexane to its alcohol and ketone derivatives has come from Loder.[2] In a typical experiment, 1008 grams cyclohexane, 3.0 grams cyclohexanone (initiator) and 0.5 grams cobalt naphthenate (catalyst) were charged to a stirred autoclave. The mixture was heated to 145°C under a pressure of 350 psi and air was bubbled through the mixture for 113 minutes. The product had 871 gr. cyclohexane and 148 gr. cyclohexanol plus cyclohexanone.

An important feature of this process is the use of low conversion rates per pass. As the allowed degree of oxidation is increased, yield drops because of the formation of higher oxidation products. Furthermore, reaction rate drops as the degree of oxidation progresses, and oxygen absorption eventually becomes negligible.

Actually, the original version of the process was found to be unsuitable for plant operation.[3] Laboratory results had indicated a yield of useful products in the range of 85-95% when per-pass conversion was held below 5%. At about 10% conversion, the laboratory still showed 60-85% yield. It was not possible to operate commercially and not exceed 70% yields at 10% pass conversion.

The difficulty was traced to the eventual accumulation of benzene and other hydrocarbons in the recycle cyclohexane, as well as to the presence of sulfur in the feedstock. It was furthermore found that improved conversion and yields could be obtained by removing the water of reaction as it is formed. Unless water of formation is removed, the reaction comes to a standstill after about 25-30% conversion.

Considerable improvement in cyclohexane oxidation performance was made by Hamblet and Chance[3] by removing water, as well as hydrocarbon impurities, azeotropically during the reaction progress.

This approach makes it feasible to employ as feedstock a petroleum-derived cyclohexane that contains not only some sulfur but also benzene in a concentration of several tenths of a percent plus close-boiling aliphatic and naphthenic hydrocarbons. These materials, if accumulated in the recycle stream, interfere with the oxidation reaction.

Hamblet and Chance report these impurities in a typical feedstock cyclohexane: Sulfur, 0.15 + wt.%; n-hexane, 1.5-3.0%; benzene, 0.1-10%; methyl cyclopentane, 2.0-18%; dimethyl pentane, 5.0-20%.

The process is carried out continuously. Several (3) stirred autoclaves, set in series, serve as reaction vessels. Each autoclave is equipped with an overhead reflux condenser, provided with means for water withdrawal. Air enters the bottom of each autoclave. (See flow diagram.)

Effluent from the final reaction stage is steam-distilled for the overhead removal of hydrocarbons. The bottoms is the desired crude oxidation product. The overhead is water-washed and then subjected to azeotropic distillation for overhead removal of (sulfur-free!) benzene and other hydrocarbon contaminants and bottoms recovery of cyclohexane to be recycled to the first oxidizer stage.

In this process, too, the usual considerations in air oxidation reaction apply (e.g., use of initiator, cobalt, naphthenate catalyst, etc., as described above). Operating temperature is stated to be 125-165°C, and a corresponding system pressure (50-250 psi) must be maintained. Per-pass conversion is 12-15% for large-scale operation. This provides a yield of (pure) cyclohexanol and cyclohexanone of 60-75%, but the yield of *total products convertible to adipic acid* is 80-85% of theory.

At reasonably low conversion, the product of cyclohexane oxidation is predominantly cyclohexanol and cyclohexanone. At 15-20% conversion in the presence of a cobalt salt catalyst, the alcohol makes up 30-50% of the cyclohexane-free oxidation product. In non-catalytic operation, formation of cyclohexanol is smaller.

Numerous side reactions occur at the same time. About 1% CO_2 is found in the tail gases. The aqueous layer separated from the oxidation products contains organic acids (60% formic, the rest mainly acetic acid). Numerous higher oxidation products have been identified in the organic layer. Among them, adipic acid is the only one present in significant amounts and its formation rises rapidly with increasing conversion per pass.

Indeed, air oxidation of cyclohexane in the liquid phase can be carried out at conditions that lead directly to the formation of adipic acid in reasonably good yield. Single-step processes based on this observation will be discussed

later. Yields obtainable in two-step operation, whereby air oxidation is limited to the preferential formation of cyclohexanol and cyclohexanone, are commercially more attractive, however. These products are converted to adipic acid, normally by oxidation with nitric acid.

The best overall yield is attained, in such a process, by carrying out the air oxidation of cyclohexane at conditions that provide the highest possible cyclohexanol and cyclohexanone content in the oily oxidation product.

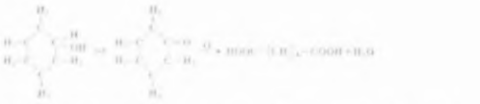
Three basic approaches are possible to this objective:[4] control of conversion, control of temperature, and continuous removal of cyclohexanol and cyclohexanone from the products. Of these, the most significant control factor is the per-pass conversion.

At 130°C, optimum overall results (i.e., yield of adipic acid based on cyclohexane) have been reported at 15-20% conversion in the air-oxidation stage. Further reduction in conversion did not cause marked improvement.

In the same series of experiments, non-catalytic air oxidation (at 145-160°C) of cyclohexane as the intermediate step for adipic acid production was found to lead to better overall yields than catalytic conversion. Table 1 shows results at varying conditions in pilot plant work.

Adipic Acid from Cyclohexanol and Cyclohexanone

Nitric acid, NO_2, and air have been proposed as agents for the oxidation of cyclohexanol and cyclohexanone to adipic acid:



It is, of course, possible to use refined cyclohexanol and cyclohexanone as starting materials for the reaction.[2] However, it is more profitable to use the crude product of cyclohexane oxidation. This saves an intermediate refining step. Furthermore, some adipic acid is already present in the crude hexanol-hexanone mixture and various by-products are also present which yield adipic acid upon nitric acid oxidation.

According to Lindsay,[9] typical adipic acid yield on cyclohexane is 52% if the intermediate products are refined. On the other hand, an overall yield of 63% can be obtained by running the crude primary oxidation products directly to the adipic acid manufacturing stage.

Oxidation by nitric acid—An early process for the conversion of purified cyclohexanol to adipic acid was practiced at Ludwigshafen.[10] There, the purified raw material had to be used because it was not obtained by cyclohexane oxidation as described above (instead, it was obtained by catalytic hydrogenation of phenol).

The Ludwigshafen adipic acid process was non-catalytic and was carried out on a batch basis. Nitric acid (54%) together with mother liquor (from a later centrifuging step) was charged to the reactor and cyclohexanol was introduced with careful temperature control at 65-70°C.

After cyclohexanol addition had been completed, the mixture was held for another 30 minutes and then cooled to 20°C. The resulting adipic acid slurry was centrifuged. Mother liquor from the centrifugation step was recycled to the oxidation reactors.

The crude adipic acid (filter cake) was washed with cold water and finally re-crystallized from water. Plant yield ranged from 81 to 85.6% of theory (based on cyclohexanol). Net nitric acid consumption in this process is reported at 1.5 lb/lb adipic acid.

The use of catalysts has been variously recommended for nitric acid oxidation of cyclohexanol and cyclohexanone. One German plant (Leuna) oxidized cyclohexanol by means of 68% nitric acid at 40-45°C, using manganese acetate catalyst. Adipic acid yield was reported at 87.5% of theory. Since these wartime processes were run, considerable progress has been made in the understanding of the control variables. Yield in modern plants is of the order of 93% (and calculated yields are even higher when a crude oxidation mixture serves as intermediate).

Several catalysts are found to have significantly favorable effect on reaction yield and commercial practice is based on this finding. Reference has already been made to the use of manganese acetate at one commercial installation. The favorable action of this catalyst and of others (soluble mercury, vanadium, molybdenum salts) was recognized in the mid-1920's. Further improvements can be obtained by the use of modifiers with these basic catalysts. Thus, Amend[10] claims significant benefits for the use of a mixture of manganese and barium acetates as catalysts in the nitric acid oxidation of cyclohexanone.

The usefulness of copper salts as yield improver was noted by Perkins.[11] It is noteworthy that copper has no particular effect at the standard oxidation temperature (55-60°C) but that it can boost yield appreciably at 80°C (i.e., its effectiveness rises with increasing temperature). The opposite phenomenon is observed with vanadate salts which lose their valuable yield-improving property as the reaction temperature is raised.

Lindsay points out that the temperature range for best yield can be widened by use of a copper-vanadium catalyst (approximately 0.25% Cu and 0.1% V). Such a system permits yields of 90-93% at temperatures ranging from 55 to 85°C and with nitric acid of 50-60% strength.

The synergistic effect of vanadium and copper as yield-improving catalysts in this reaction is borne out by the data of Table 2, which is based on work by Hamblet and McAlevy.[10] The feed in this instance was a crude mixture obtained in the course of air oxidation of cyclohexane.

Table 2—Vanadium and Copper as Adipic Acid Yield-Improving Catalysts for Nitric Acid Oxidation of Cyclohexanol-Cyclohexanone

Catalyst (concentration expressed as % of HNO_3 solution)	**Yield** (lb. adipic acid per lb. feed)
None	0.631-0.637
0.05% NH_4VO_3	0.760-0.920
0.05% NH_4VO_3 + 0.15% dissolved Cu	0.999-1.017

By-product dibasic acids of lower molecular weight (notably succinic acid, but also glutaric and oxalic acids) are formed during the nitric acid oxidation of cyclohexanol and cyclohexanone to produce adipic acid.

Aronow[10] claims that the formation of such by-products can be largely suppressed and adipic acid yield correspondingly increased by maintaining a low concentration of nitric acid at all times. Oxidizing agent and cyclohexanol are added continuously to a relatively large body of reaction liquor. Product is withdrawn at a rate equaling the volume of incoming streams.

In a continuous process of this type, it is possible to hold nitric acid concentration in the reaction zone at the claimed optimum of 6-10%, though a stronger acid (50-70%) is introduced to the system. Best reaction temperature is reported at 70-85°C and a catalyst (e.g., vanadium) is used. Reaction time is 1-5 minutes.

The reactor make is cooled to approximately 30°C.

Enough time is allowed for formation of suitable adipic crystals. The resulting slurry is centrifuged. Mother liquor is sent to a nitric acid concentrating still. Adipic acid yield is stated to be 90-95%. It may be purified by recrystallization from water or a solvent such as MEK.

A continuous process, with low local concentration of nitric acid is also covered by Hamblet and McAlevy.[9, 10] This more recent work recognizes the superiority of crude cyclohexane oxidation product over refined cyclohexanol and cyclohexanone when used as feed to adipic acid synthesis. The crude air-oxidation product is freed of unconverted hydrocarbon prior to HNO_3 oxidation.

In Hamblet's process, cycloalkane-free product of the preliminary air oxidation and a nitric acid solution of 50-60% strength, containing copper-vanadium catalyst, are separately and continuously introduced into a reaction tube through which the reaction mixture is rapidly circulated. The system pressure is 2-10 atmospheres. Temperature is held at 60-80°C. By jacketing the reaction tube, heat removal from the circulating reaction mixture to external coolant may be readily effected.

The preferred weight ratio of nitric acid stream to organic feed is between 15 and 25. Weight ratio of 100% nitric acid in the feed to organic feed is between 2.5 and 6.0. The rate of admittance of organic feed to the recirculation system should be such that the average contact time is of the order of five minutes. Since gaseous nitrogen oxides are evolved in the course of reaction, provision must be made for their removal from the system, their recovery, and their eventual reoxidation to nitric acid.

Hamblet reports that substantial improvement in yield can be achieved by following the relatively mild primary nitric acid oxidation step described in the preceding paragraphs, with a second, more drastic, oxidation stage.

For this purpose, a stream of primary oxidation mixture is continuously withdrawn from the circulating system. The effluent is heated to 95-100°C and held at this temperature for about 7 minutes. The continuing exothermic reaction must be controlled by external cooling.

Crystallization of adipic acid from the reaction mixture is effected by cooling and the product is recovered by centrifuging. Mother liquor is vacuum flash-distilled for overhead recovery of nitric acid.

Choice of process is controlled by plant size. The breakpoint is estimated to be at a capacity between 8 and 15-million lb/yr adipic acid. Batch process may be carried out economically in very simple equipment at small installations. In larger plants, the higher investment for continuously operated processes is paid out by improved yield, higher recovery of the off-gases of the reaction (nitrogen oxides) and reduced labor needs per unit production.

Chemical engineering problems met in the design of continuous plants for the nitric acid oxidation of cyclohexanol-cyclohexanone mixtures to adipic acid have been given an excellent account by Lindsay.[5] Three different designs are considered. In each, allowance is made for 2-stage reaction whereby the second stage is operated at higher temperature than the first. The yield-improving feature of such two-stage conversion has been considered above in connection with Hamblet and McAlevy's process.

The simplest type of continuous process uses a series of two jacketed, agitated reaction vessels (preferably suitable for pressure operation). In this arrangement, the second reactor can be used to finish the reaction at higher temperature than that of the first stage. Using a refined starting mixture, yields better than 90% can be attained in this equipment. As pointed out above, the apparent yield from a crude feed mixture is even better.

According to Lindsay, this simple type of reactor system is not recommended for plant capacities above 20-million lb/yr. Here, the high heat removal requirements call for the large transfer surfaces offered by tubular heat exchangers. Toward this end, either shell-and-tube reactors may be used or, if a cascade system of two reactor vessels in series is preferred, the liquid reaction mixture may go through external shell-and-tube heat exchange.

Either way, two reactors in series are employed. Typically, the first is run at 70°C and the second at 100°C.

Provision must be made for the disengagement of evolved gases (mainly nitrogen oxides) from the reaction phase. With autoclaves, this is adequately achieved within the vessel provided that the diameter is large enough to result in a superficial off-gas velocity less than 500 ft/hr. For separation of gases evolved in tubular reactors, cyclones may be provided.

Following disengagement of the off-gases, contained nitrogen oxides must be recovered and reoxidized to HNO_3.

Each of these reactor systems employ a large circulation rate around the first of the two reactors. This permits continuous injection of strong nitric acid and organic feed into the circulating stream while maintaining low concentration of either in the main body of the system. Such design is in accordance with the precepts outlined above in the discussion of Aronow's and of Hamblet's work.

With tubular reactors, the hazard of local over-concentration is minimized by using efficient injection systems and turbulent flow of the circulating liquid. Where autoclaves are used, the feeds may also be injected into the liquor circulating through the external heat exchanger. However, Lindsay reports good performance also when the organic feed is introduced into the first autoclave below the liquid surface and close to an efficient agitator.

As typical operating data, in continuous reactors with external recirculation, Lindsay cites a ratio of nitric acid (calculated as 100% HNO_3) to organics of 4.5:1. Feed acid strength is about 53%. The recycle contains about 33% HNO_3 and the concentration just downstream of the HNO_3 feed point is approximately 45%.

Ratio of recirculating liquor to organic feed may be as high as 50:1. Overall hold-up in the first reactor is 5-10 minutes and a like period is provided in the second conversion stage. Copper-vanadium catalyst is used.

At such operating conditions, yield in the primary reactor is better than 90%. A boost of some 3% can be attained in the second converter.

Gaseous By-Product and Adipic Acid Recovery

Useful recovery of nitrogen oxides evolved in the course of oxidation by nitric acid is an economic essential of adipic acid manufacture. Toward this end, the off-gases from the reaction stages are scrubbed with water or, preferably, with nitric acid. Additional nitrogen oxides are recovered from the liquid product phase of the secondary reactor by passing this stream through a stripper in countercurrent contact with air at approximately 90°C.

The absorbed off-gases are oxidized to nitric acid by contact with air in an auxiliary installation.

The liquid oxidation product issuing from the air-stripper is fed to a steam still. Here, certain objectionable impurities are removed overhead, among them notably valeric and butyric acids. At the same time the aqueous reaction liquor is concentrated to aid subsequent crystallization of adipic acid and to get a mother liquor suitable for recycling to the reactors (except for a purge stream).

There is advantage in operating this concentration

still at reduced pressure. At the resulting lower temperatures, the severity of the corrosion problem is lessened. At the same time, boiling temperature must be slightly above 70°C to prevent deposition of adipic acid in the still.

The final recovery step involves crystallization of adipic acid from the concentrated reaction liquor, as has been noted. This step is advantageously carried out at 40-50°C because the operation at lower temperatures is slow to the point of being uneconomical. Following centrifuging, mother liquor is recycled to the nitric acid oxidation step (contained adipic acid is stable at reaction conditions).

In the course of such recycling, impurities build up. Among them, succinic acid is the most objectionable. Contamination of adipic acid by more than 0.1% succinic acid is deleterious to the spinning and dyeing characteristics of nylon-66.

One way to avoid accumulation of succinic acid to where it will co-crystallize with adipic acid, is to take a sizable bleed-stream.

Two-step crystallization of adipic acid from the nitric acid recovery system is an attractive alternative, according to Hamblet and Gee.[11] Resulting recovery is reported to be 96%.

In this process, liquor leaving the concentration still is cooled to 50°C, at which temperature crystallization is allowed to take place. The nitric acid and mother liquor (approximately 40-50% HNO_3) is separated from the adipic acid crystals, and is subjected to distillation until its volatile content has been reduced to about 30%. Overhead is recycled to the reaction stage.

The residual mother liquor is diluted with water to a nitric acid content of 10%. Thereby, adipic acid solubility is reduced and viscosity of the system is lowered. The diluted stream is cooled to 30°C for the crystallization and recovery of more adipic acid.

The secondary mother liquor is passed to an evaporator for the recovery of its dilute nitric acid content, which is returned to the system. The residue from this step may be discharged after treatment for any desired contained organic values and for elimination of its pollution characteristics. The ratio of adipic acid to succinic acid in this waste stream is only about one-half of that obtained in single-step crystallization.

Alternate Routes from Cyclohexane to Adipic Acid

These methods include two single-stage processes—one in which air serves as oxidizing agent and one in which only nitric acid is used. Finally, there are 2-stage process in which a cyclohexanol-cyclohexanone mixture is produced by conventional air oxidation and the product is oxidized either by air or by gaseous nitrogen oxides.

As we have seen, air oxidation of cyclohexane at mild conditions will tend to stop at cyclohexanol and cyclohexanone. On the other hand, more drastic conditions will lead to complete combustion of the hydrocarbon.

In the single-stage air oxidation of cyclohexane to adipic acid, it is therefore necessary to choose intermediate conditions carefully and maintain them by proper control.

According to Loder[12] the reaction must, of course, be carried out in the liquid phase. Temperature should be held below 120°C. Oxidation catalysts are of the same type as those described for conversion to cyclohexanol-cyclohexanone mixtures. Similarly, an initiator, such as cyclohexanone, must be present in adequate concentration (larger than 0.1%) throughout the reaction period. As with 2-stage oxidation, the use of elevated pressure (beyond that needed for maintaining a liquid phase) has the advantage of improving reaction rate.

The main point of difference from conversion to cyclic alcohols and ketones is the use of a solvent if single-stage synthesis of adipic acid is desired. Of numerous solvents described by Loder for the purpose, glacial acetic acid appears to be most useful. Largely because of acetic acid's corrosiveness, Wadsworth[13] prefers the use of acetone as solvent for cyclohexane oxidation. The latter is said to be stable at oxidizing conditions *only* in the presence of cycloalkanes and in the absence of acetic acid. A further disadvantage of acetic acid, not shared by acetone, is the formation of esters with alcohols in the reaction mixture and difficulty of recovery.

Ultimate adipic acid yield in single-stage air oxidation is of the order of 50%.

Single-stage HNO_3 oxidation of cyclohexane to adipic acids is covered in the patent literature.[14,15] But because of low yield (25-30%) and high reagent cost, it does not appear particularly promising.

Single-stage NO_2 oxidation of cyclohexane has been reported to give adipic acid yields up to 98%,[16] based on oxidizing agent. However, good yield is obtainable only at low temperatures (50°C) and calls for very long reaction time.

Several process versions, alternate to commercial nitric acid oxidation, permit the conversion of cyclohexanol-cyclohexanone mixtures to adipic acid.

Air oxidation of cyclohexanone may be carried out at 60-70°C in the presence of a small amount (0.1 wt. %) potassium permanganate and of actinic light. By separating solid adipic acid from the reaction liquor and recycling the latter, this process is claimed[17] to provide near-quantitative adipic acid yield from cyclohexanone.

Finally, mention must be made of a process[18] in which liquid nitrogen dioxide serves for the oxidation of cyclohexanol to adipic acid. Carried out at 120°C, with a NO_2: cyclohexanol initial feed ratio of 5:1 and with a reaction time of 2½ hours, a yield slightly above 60% of theory (based on alcohol) was obtained.

References

(1) Anon. *Chemical Week*. Jan. 8, 1955, pg. 55.
(2) Loder, D. J. U. S. Patent No. 2,223,494 to E. I. du Pont de Nemours & Co., Dec. 30, 1940.
(3) Hamblet, C. H. and F. S. Chance. U. S. Patent No. 2,557,281 to E. I. du Pont de Nemours & Co., June 19, 1951.
(4) Smith, L. H., et al. *CIOS Final Report No. XXXIII—50*, p. 580 ff.
(5) Lindsay, A. F. *Special Supplement to Chemical Engineering Science*, Vol. 3, 1054, pp. 78 ff.
(6) Amend, W. J. U. S. Patent No. 2,316,543 to E. I. du Pont de Nemours & Co., Apr. 13, 1943.
(7) Perkins, R. P. and A. J. Dietzler. U. S. Patent No. 1,960,211, 1934.
(8) Aronow, A. M. U. S. Patent No. 2,191,786, Feb. 27, 1940.
(9) Hamblet, C. H., et al. U. S. Patent No. 2,557,282 to E. I. du Pont de Nemours & Co., June 19, 1951.
(10) Hamblet, C. H. and A. McAlevy. U. S. Patent No. 2,439,513 to E. I. du Pont de Nemours & Co., April 13, 1948.
(11) Hamblet, C. H. and R. E. Gee. U. S. Patent No. 2,713,067 to E. I. du Pont de Nemours & Co., July 12, 1955.
(12) Loder, D. J. U. S. Patent No. 2,223,493 to E. I. du Pont de Nemours & Co., Dec. 3, 1940.
(13) Wadsworth, F. T. U. S. Patent No. 2,589,648 to Pan American Refining Corp., March 18, 1952.
(14) Ellingboe, E. K. U. S. Patent No. 2,228,261 to E. I. du Pont de Nemours & Co., Jan. 14, 1941.
(15) Cavanaugh, R. M. and W. M. Nagle. U. S. Patent No. 2,343,534 to E. I. du Pont de Nemours & Co., March 7, 1944.
(16) Hoot, H. F. and K. A. Kobe. *Industrial Engineering Chemistry* 47, April 1955, pg. 782.
(17) Prückner, H. U. S. Patent No. 2,341,288 to E. I. du Pont de Nemours & Co., Feb. 8, 1944.
(18) Kenyon, W. O., et al. U. S. Patent No. 2,298,387 to Eastman Kodak Co., Oct. 13, 1942.

Today You Need

Better Supervision of Engineers

Handling the technical man takes special skill. Here are the reasons why, and how to get results.

TODAY'S competition for engineers makes good supervision of technical workers an urgent matter for the oil industry. Once a man is hired, management has to make the most of his productivity.

But how is supervision of the technical worker different from supervision of any other employe? And how must managers modify their standard personnel methods to allow for the difference?

Some light was thrown on these questions by the panel of managers that took part in the symposium "Supervision of Engineering and Scientific Personnel" at the Los Angeles meeting of the American Institute of Chemical Engineers, Feb. 26-29.

The panel agreed, generally, that the key to good supervision lies in knowing what kind of men engineers and scientists are: individualists who are usually intelligent, sensitive and creative.

Full identification of the panelists is given elsewhere on the page. Here are their tips on good supervision.

Define the Job

First, the engineer must know clearly what he is supposed to be doing. Good job descriptions are important, though they can't be too detailed or binding, particularly in research and development work. One approach outlined by Martin was to define not the job but the problem on which the engineer is working. At Procter & Gamble, he said, the problem is discussed with the engineer, and then he himself writes a description of it, which greatly reduces possibility of misunderstanding.

However you do it, the panelists agreed, the engineer must have no doubts about what is expected of him.

Appraise Work Systematically

For the sake of both management and the engineer, there must be systematic appraisal of the engineer's work.

"The best job is done by day-to-day, on-the-job evaluation," said Sandberg, of Cutter Laboratories.

But it was generally agreed that this should be supplemented by reviews at least every six months. The reviews should be carefully thought out and should include such questions as "Does he follow instructions?", "Is he good at delegating work?", "How does he take pressure?", "Does he write good reports?", "What is his over-all productivity?"

The immediate supervisor makes the controlling evaluation, but this should be supplemented by the judgment of others—for instance, by the man over the supervisor.

In the periodic reviews, attention must be paid to changes in performance and attitude—to signs of growth.

Martin cautioned against making appraisals too cut-and-dried.

"Weaknesses are sometimes the opposite side of strengths," he said, and you don't want to damage the strengths. A highly creative person might be weak when it comes to carrying things out. But to make too much of that fact could inhibit his inventiveness.

On the other hand, a good detail man may not be highly inventive, yet criticism on this could discourage him needlessly.

In short, use the man's strengths and don't mix him up by trying to make him what he's not.

Talk Over the Appraisal

These appraisals should be made known to the engineer, the panelists agreed. It's vital for him to know not only what's expected of him, but also where he stands and what is thought of him. But there was disagreement about the best way to tell him.

Lunz thought there was value in regular talks, tied to the periodic reviews.

Martin, however, felt that appraisals should not be scheduled arbitrarily, that the supervisor should take advantage of the right opportunity—another recognition of the engineer's sensitivity.

Keep Promotions Flexible

The panel believed this was important for morale. But promoting from within the company requires a systematic approach, especially in a big

Who's on the Panel?

Robert W. Krebs, Associate Director, Esso Laboratories, Esso Standard Oil Co., Baton Rouge.

T. Robert Sandberg, Vice-President of Production, Cutter Laboratories, Berkeley, Calif.

L. T. Lunz, Training Director, Queeny Plant, Monsanto Chemical Co., St. Louis.

W. S. Martin, Director of Product Development, Procter & Gamble, Cincinnati.

A. L. Lyman, President, California Research Corp., San Francisco.

Robert D. Gray, Professor of Industrial Relations, California Institute of Technology, moderator.

company where there are many candidates.

A promotion scheme should be flexible. For instance, a new supervisor for a group need not come out of that group. But this policy must be made clear to everyone, or a promising man may be discouraged if he sees his chances blocked for promotion directly up the line.

"A young man shouldn't feel he can only look up one ladder," commented Lyman, of California Research Corp.

What About Salary?

While recognition is important, paycheck recognition isn't the only kind, and perhaps not the most important kind (there was unexpected laughter when one panelist suggested that a pat on the back meant more than a raise). In any case, the "green stuff" is important, and fair salary schedules are essential but difficult, it was agreed.

Beyond the routine raises of the first years, flexibility and judgment are called for, Martin observed.

Lunz opposed automatic raises based on length of service. When raises are based on effort, he said, you obtain more benefit in motivation.

The problem of relating salaries of technical people more closely to salaries of administrators received a lot of attention.

As Lyman put it: "You can't withhold compensation from a technical specialist because you don't want to lose his talents in an administrative job."

Krebs observed that he would like to see salaries of specialists rise to the point where management can't pull them into administration.

What Makes a Good Supervisor?

As moderator Gray put it, the supervisor's prayer is to this effect:

"Dear God, give me all the qualities that make a good supervisor—and then, God, move over."

Lyman listed these as desirable attributes of the first-line supervisor—the section head or project supervisor:

1—Training and good reputation in his field.

2—Ability to deal with the technical problems met by his men.

3—Analytical and creative ability.

4—Ability to delegate work and willingness to let the men work freely within the delegated area.

5—He can appraise men and act on his appraisal.

6—Tact and the courage to support his men with management.

Company Attitude Is Important

Creation of a good working climate is a major function of all these supervisory tools, the panelists agreed. The whole attitude of the company is involved in this working climate.

Krebs pointed out that because creativity is part of every engineer's job, the company should expect it from the start. But the company has the responsibility of nourishing creativity, and this means that there must be a willingness to change, to welcome new ideas.

"If a company is receiving more good ideas than it is using, it is wasting talent," Krebs reminded.

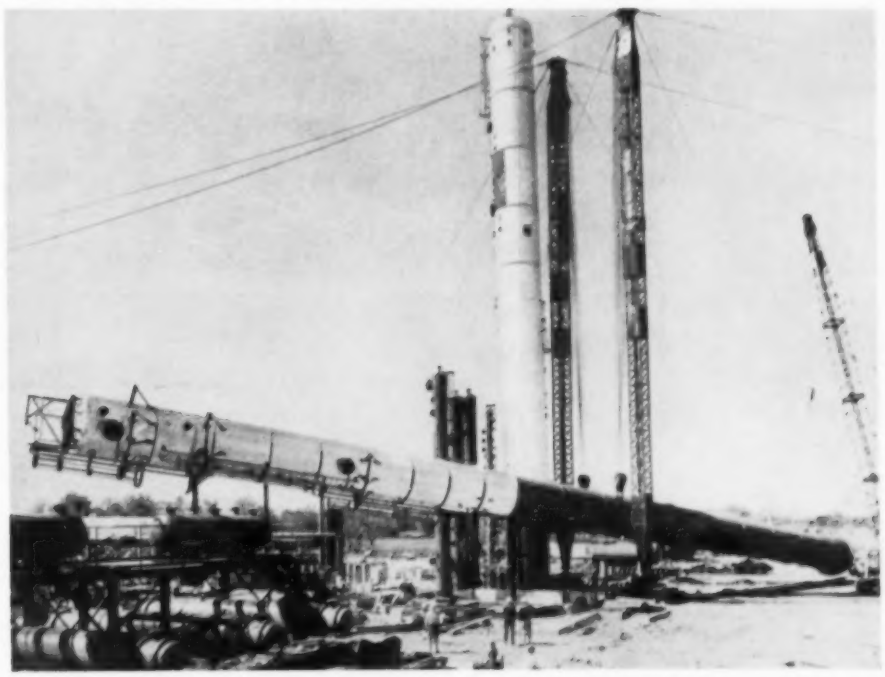
Review the Personnel System

Whatever the system, it must be reviewed periodically, they agreed.

Lyman spoke of a poll taken among California Research employes by an outside agency. It uncovered a feeling among the engineers that they didn't know where they stood. The company had thought that its system was handling this factor effectively.

Said Sandberg: "What the engineer is actually thinking—not what you believe he is thinking—is the important thing."

NEWS in VIEWS



TWENTY STORIES UP is the goal of this 186-ft. tower being installed in American Cynamid's new mono-methylstyrene plant at Avondale, La. Tower, 8 ft. in diameter and weighing 293,000 lb., was built in one piece by Delta Tank Mfg. Co. at Baton Rouge, La., and shipped to the plant site on four flat cars

THE PROBLEMS ARE TOUGH—arrow points to 9 tons of steel being jockeyed into position atop cat cracker

6 Turnaround Problems and How We Solved Them

1—Planning and Making Preparations
2—The Regenerator and Its Cyclones
3—What to Do with Eroded Slip Joints
4—Reactor Repairs, Cyclones, Linings
5—Replacing the Slide Valves
6—Trouble in the Catalyst U-Bends

By J. B. ADAMS, Mechanical Superintendent, Lion Oil Co., El Dorado, Ark.

BEST executed and best planned turnaround in our refinery's history—that's the way we feel about the recently completed job on the Model IV Fluid cat cracker, vapor recovery, and sulfuric acid akylation units at our El Dorado, Ark., refinery.

Although these units had been off stream several times for adjustments and special repairs since their completion in 1953, they had never been opened for a complete inspection and overhaul until this job.

Just 21 days after we went offstream we were able to turn the units back to the operating department for start-up. Good planning and excellent cooperation made this record possible. Ideal weather helped, too. Temperatures stayed in the 60's and 70's, and there were less than three hours of rain in the entire 21-day shutdown period.

We met and solved some interesting problems among the 600 or so jobs involved in this turnaround. Only the most important ones will be discussed here, however.

• 1 Planning and Making Preparations

PLANNING for the turnaround began some three or four months before the actual shutdown date. We based our plans on findings of previous short shutdowns and partial inspections. Over 600 individual jobs were tabulated and fitted into the plans.

A preliminary list of work to be done was then turned over to the mechanical department for preparation of detailed labor estimates six weeks or so before shutdown date. These labor estimates were broken down into separate crafts to give an accurate and true picture of personnel requirements. The estimates also established the amount of offstream time required for the turnaround. This helped the operating department make its own plans for readjustment of refinery runs to compensate for the extended interruption in their schedules.

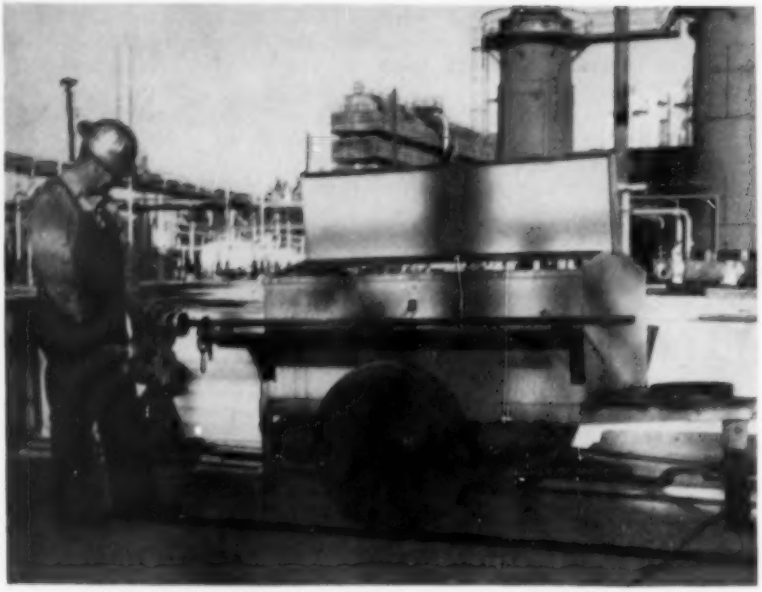
After the estimates were completed and tabulated, we held a regular preshutdown meeting in the superintendent's office. The group included the operating superintendent, mechanical superintendent, chief engineer, assigned shutdown engineer, area maintenance engineer, and the chief equipment inspector. Purpose of the meeting was to discuss and evaluate those extraordinary and major time-consuming items listed in the mechanical department's labor estimates, and to discuss personnel available for assignment to the different phases of the work.

After discussions were completed and unjustified items were deleted together with some items that could be postponed to help eliminate labor bottle-necks in certain crafts, the mechanical department estimated that 21 working days were needed for the work necessary with the units off stream. This estimate was based on plans to

ALL THE TOOLS NEEDED for entire turnaround are stored in this mobile unit and moved into the job area the day before the shutdown

COMPACT, NEAT AND ORDERLY—that's the arrangement inside the mobile tool room for fast handling of hurry-up calls

Author Adams is a previous contributor to PETROLEUM PROCESSING, and a biographical sketch will be found accompanying his article in the March issue, p. 98.)



FOR SPECIAL JOBS—SPECIAL TRAILERS complete with electric power tools facilitate handling all jobs possible at the job site

work one ten-hour shift per day with the exception of the cyclone work in the regenerator and the cyclone work and feed-riser lining in the reactor, where welders and boilermakers would be available for two shifts during the last 10 days of the turnaround.

The final work lists were then prepared by the assigned shutdown engineer and issued to the mechanical department three weeks before the shutdown date. All equipment, material and tools were moved to the unit during this period. They were stored in a convenient place where they would not interfere with operation of the unit until it was brought down. The rigging equipment was set and strung up, scaffolds erected, and trolleys and chainfalls mounted on monorails where needed. Welding machines were set and cables strung to locations where welding work was to be done. Acetylene and oxygen manifolds were installed with permanent lines running to the top of the reactor and regenerator structure. Take-off manifolds were installed at convenient locations.

All hand and power tools required for the complete turnaround were transferred to an 8 by 20-ft. mobile tool room, shown in the photographs, which was moved to the unit area the day before the unit was shut down. Tools were issued from this tool room on an individual check system by the attendant on duty during the day shift only. Because of the limited number of night workmen, night cleanout foreman dispensed tools then.

We later determined that the mobile tool room saved from 15% to 18% of the total man-hours required for a turnaround compared to the usual practice of working out of a central tool room in the shop area.

The mobile tool room also saved us 60% in trucking costs chargeable to the turnarounds, and another 30% in tool requirements. The unit made it convenient to return tools when the jobs were completed, making the tools immediately available for use by other workmen. This mobile tool room is equipped with a tool check-out board and dispensing counter, tool storage cabinets and repair bench, fan type space heater for winter use, electric fan for summer use, and electric lights. It also has a telephone that plugs into the plant system, furnishing communication to the central tool room. This makes it simple to order additional and special tools when needed, and permits foremen to order trucks, materials and supplies from the shops and warehouses, as well as giving them contact with any other part of the plant.

Special small trailers were also moved to the unit, to allow as much of the craft work as possible right in the area instead of back in central shops. This included such crafts as pipefitters, boilermakers and mechanics.

These trailers were fitted with trays for storage of tools, materials and parts pertaining to the particular crafts to which they are assigned. The one shown is stocked for pipefitters. It's complete, with electric portable pipe dies, hack saw, and vise.

There were, however, many tasks—such as the retubing of four large heat exchangers and major repairs to pumps and turbines, etc.—that were performed better and more efficiently in the shops where proper facilities and working conditions were available.

An effort was made during the first day of the turnaround to open and vapor-free all equipment and lines so that welding work would not be interrupted once a fire order was issued and welders were moved on the job. Every welding job was handled on an individual fire order, renewed at the beginning of each shift to assure complete safety from fire and explosions.

Our labor estimates indicated that length of the turnaround would be greatly influenced by the progress of cyclone work in the reactor and regenerator. We therefore gave these two jobs priority in assigning personnel and equipment.

Because of the nature and size of the turnaround, it was carried-out under the direct supervision of the mechanical superintendent who remained in the turnaround area during the entire cleanout period. He was assisted in coordinating the work during the day shift by the general maintenance foreman who divided his time between the turnaround proper and maintenance work in other parts of the refinery. Five craft foremen were also assigned to the turnaround on the day shift. All night shift work was done under the direction of one foreman.

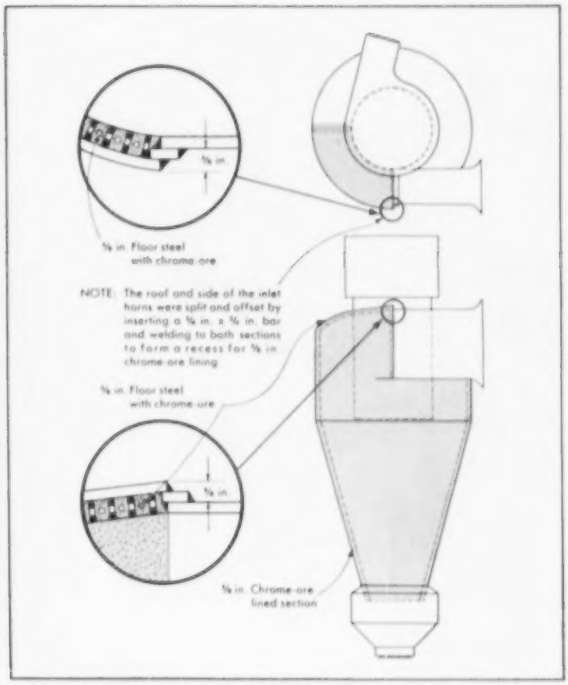
The turnaround, together with all other priority refinery maintenance work, was done with a complement of eighty-five craftsmen and helpers plus six utility pool helpers. Eight laborers were also assigned to the turnaround a major portion of the time. They handled general clean-up work and cleaning ahead of the painters.

The entire turnaround, as mentioned, was carried out under ideal weather conditions. There were less than three hours of rainfall during the three week period. Prevailing temperatures ranged between 60° and 75° F.

The morale of the workmen was excellent, with complaints nil, even though craft classifications were ignored by consent. At least half of the men worked across craft lines or in crafts other than their own for the entire period. This arrangement gave us maximum utilization of available manpower. It also provided an incentive for productivity by offering premium pay for many workmen in those crafts not normally requiring overtime work.

2 The Regenerator and Its Cyclones

HEAVY REPAIRS NEEDED—badly burned regenerator primary cyclones after one year of operation


⅝ in.
⅝ in. Floor steel with chrome ore
NOTE: The roof and side of the inlet horns were split and offset by inserting a ⅝ in. x ⅝ in. bar and welding to both sections to form a recess for ⅝ in. chrome ore lining
⅝ in. Floor steel with chrome ore
⅝ in.
⅝ in. Chrome-ore lined section

HOW CYCLONES WERE REPAIRED with chrome-ore reinforced with floor steel without reducing inlet cross-sectional area

THE regenerator had been fitted originally with seven sets of two-stage, unlined, A-285 carbon steel cyclones, ¼-in. thick. After the first year of operation, the catalyst losses from the stack had become excessive and the Fluid unit was shutdown for an inspection. We found that the cyclones were all badly burned, warped, and eroded.

Accordingly, the problem of the cyclones and the regenerator must actually be split into three phases: 1—a job of repairs after the first year of operation, 2—installing a means for controlling the burning problem, and 3—a complete replacement of the cyclones (this last phase being done at the time of the major turnaround under discussion).

Phase 1—Repairs after First Year

We did not have any replacement cyclones and could not obtain them fast enough at the time of the first inspection. Therefore, we decided to make quick repairs and get the unit back into operation just as soon as possible.

The primary cyclones were burned and eroded almost to the point of destruction (see photo). Several of the hanger support lugs were burnt so badly that they had partially pulled out of the side of the cyclones and were hanging in a precarious position, in great danger of falling. The bulges around the support hangers were hammered back into position as well as possible, and then reinforcing pads and gussets were welded onto the cyclones to strengthen them.

In order to smooth out the warps and dents on the inner surfaces of the primary cyclones, we had to line the cylinder, the cone, and a part of the roof with a ⅝-in. thickness of chrome ore, reinforced with ⅝-in. thick floor steel.

All of this work was done in place, without decreasing the dimensions of the inlet horn (see drawing), hence the inlet velocity to the cyclones was not increased.

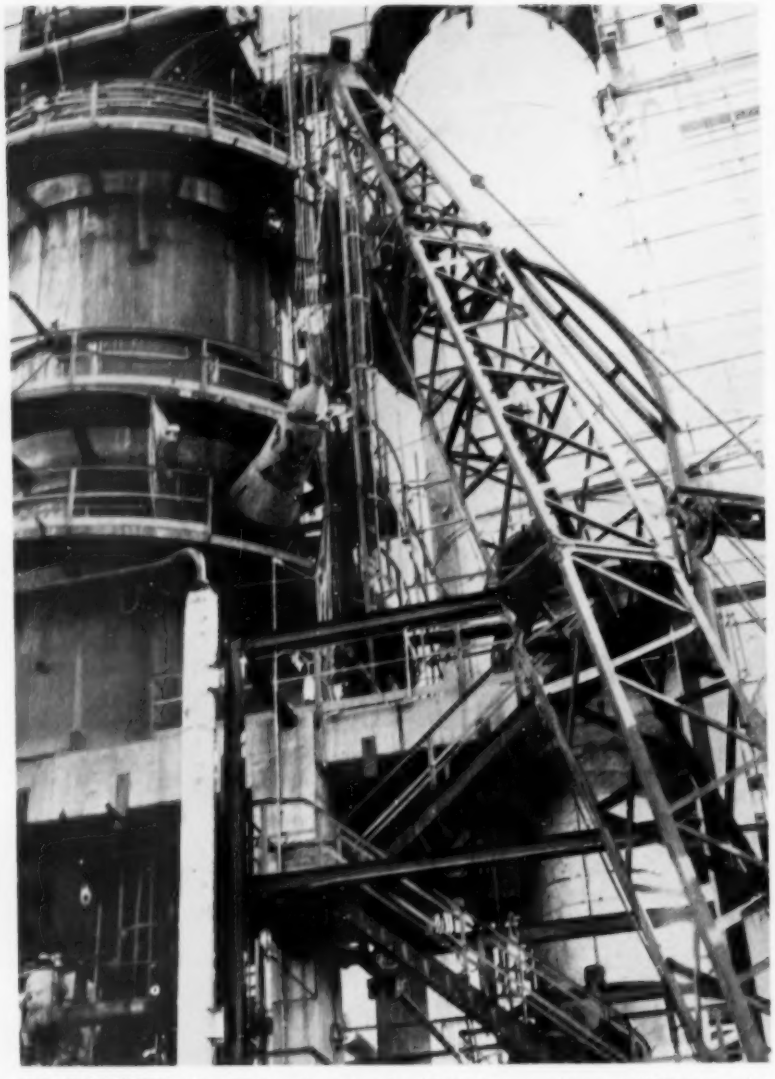
We had to replace the entire inner cylinder and the outlet stubs of all seven secondary cyclones, as well as parts of the cross-over ducts between the cyclones. We were able to work the outer cylinders and cones of the secondary cyclones back into condition fairly well without adding a chrome ore lining. But we did line the outlet stubs for protection against afterburning, which seemed to be taking place on the inside.

Although work space was extremely limited around these cyclones, we used as many as nine welders and six boilermakers at a time in placing these units back into operating condition.

Phase 2—We Had to Control Unwanted Overheating

While the unit was down at this time, we decided to install an additional 72-point electronic temperature indicator and two 12-point electronic temperature recorders. We also added

LIMITED SPACE, yet 15 welders and boilermakers work at one time to speed repairs on the cyclone



TIGHT SQUEEZE—the 53-in. diameter by 13 ft. long cyclones (4800 lbs each) were eased successfully through a 54-in. manway . . .

WHILE TELEPHONES carried directions from the regenerator to the winch-man

more thermocouples to aid in locating points of afterburning and overheating in the top of the regenerator and in the cyclones.

We then installed remote manually-operated valves in the seven 1-in. steam quench lines to the outlet of the primary cyclones, and put manual loading stations above the temperature recorders on an annex to the main instrument board. This board was located next to the regenerator section of the control panel so the operator could maintain constant control of these critical temperatures. A high-temperature alarm was provided on both of the temperature recorders to sound a horn if any of the 24 recorded temperatures went up to 1150° F.

As a final measure, we installed a 2-in. steam quench ring along with a 1½-in. cone water spray (see photo) in the dead space above the cyclones, at the top of the regenerator. These quenches were also equipped with manual valves operated from loading stations on the instrument annex board. All of the remote manual valves were installed with steam purge by-passes and restriction orifices.

The unit went back onstream and operated for another 10 months—with a catalyst loss of 1.75 ton/day.

Phase 3—Installing the New Cyclones—a Tricky Job

A new set of cyclones of different design were ordered for complete replacement at the time of the complete unit turnaround. The new primary cyclones were constructed of ¼-in. thick A-201, grade A, carbon steel, with a ¾-in. chrome ore-hexsteel lining throughout except for the outlet stub. The secondaries were of ½-in. thick A-201, grade A carbon steel, without the refractory linings.

Cyclone replacement, because of the rigging problems involved, was perhaps the trickiest job we handled. The secondary dip legs were first removed to provide working space for removal of the old cyclones and installation of the new ones. The primary dip legs were supported with cribbing from the regenerator grid and left where they were.

We decided that the best and fastest way to replace the regenerator cy-

clones was to use two different rigging crews working 180° apart—diametrically opposite each other. They used two load lines and lowered first a secondary cyclone. Then, with the same load lines, they drifted and lowered the connecting primary cyclone.

This had to be done because the only easy access to the inside of the regenerator for a load line was through the 2-in. themocouple connections immediately above the center of the secondary cyclone stubs.

The entire operation was then reversed, and a new primary cyclone was raised, drifted into position, and hung on rod hangers. Following that, the secondary cyclone was raised into position. Both cyclones were then plumbed and fastened in place by firm tack welds.

It was a job demanding good coordination. During the operation, the winch operator—on the outside of the vessel—was directed entirely by telephoned instructions from inside the regenerator. It was particularly tedious, because the cyclones weigh approximately 4800 lbs., and measure 13 ft. long by 53 in. in diameter, and had to pass through a 54-in. manway for transfer to a crane on the outside—a clearance of one inch.

Two important factors influenced our selection of this method: 1—it simplified rigging by making full use of each set-up before moving the load lines to the next location, and 2—it minimized the use of scaffolding by using the adjoining cyclones to work from during both the lowering and the raising operation.

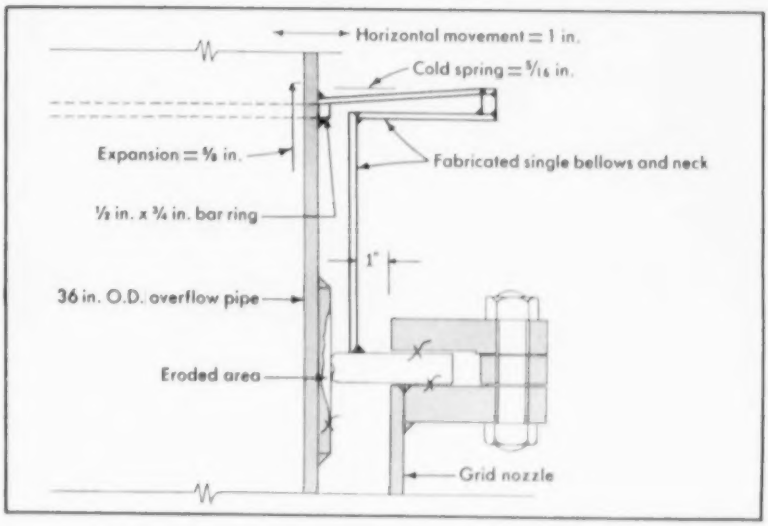
While this work was in progress, welders were busy completing work on the secondary stubs from above the plenum head. The primary and secondary dip legs were reconnected to the new cyclones while the welding was being completed on the cross-over ducts, stubs, and gussets above the cyclones.

3 What to Do with Eroded Slip Joints

AT the same time the work on the regenerator was going on, expansion bellows were installed in place of the machined slip-joints between both the 30-in. diameter catalyst riser pipe and the 36-in. diameter catalyst overflow pipe and the distribution grid.

We found that these machined slip-joints were so badly eroded that they were no longer effective. Some correction had to be made to prevent the catalyst from eroding through the large diameter pipes at these points.

The solution was in the installation of the expansion bellows and is clearly illustrated in the accompanying sketch.


Horizontal movement = 1 in.
Cold spring = 5/16 in.
Expansion = 5/8 in.
Fabricated single bellows and neck
1/2 in. x 3/4 in. bar ring
1"
36 in. O.D. overflow pipe
Eroded area
Grid nozzle

EXPANSION BELLOWS replaced an eroded slip joint around catalyst riser and overflow pipes in regenerator

4 Reactor Repairs, Cyclones and Linings

THE repairs to the four refractory lined reactor cyclones and the replacement of the 2-in. refractory-hexsteel lining in the reactor feed riser were closely coordinated with the work in the regenerator to assure that work in the two vessels would be completed as nearly as possible at the same time.

In the reactor feed-riser we had to replace a large part of the 2-in. thick refractory-hexsteel lining and the 1-in. plate, flow-straightening vane just below the distribution grid.

In the reactor cyclones we had to replace the secondary dust bowls, dip leg trickle valves and the lower half of the cyclone cone where erosion had cut completely through both the ¾-in. refractory-hexsteel lining and the ¼-in. thick outer steel shell. We decided that this lower section of the cones plus a new refractory-hexsteel lining could be replaced more quickly than the old sections could be repaired.

We also found that a groove approximately 2 in. wide and ⅜ in. deep had eroded in the exposed outside periphery of the inner cylinder of primary cyclones just below the cover plate. Because this was the only portion of any of the reactor cyclones not refractory-hex steel lined, it was built back up by over-laying with weld-metal and grinding back down to the original dimensions. Access was gained to the primary cyclones by removing the dust bowls.

Because of severe corrosion and pitting of the vessel shell in the dense phase of the reactor, an 11/64-in. Type 410 stainless steel lining was installed in that section. This work was used as a fill-in job to keep the welders busy while they were not working on the cyclones.

5 Replacing the Slide Valves

DOVE-tailed into the reactor-regenerator repair work was the task of completely replacing the lower set of regenerator stack slide valves. These valves, which were built integrally with the stack, were replaced by removing a 42-in. section of the old stack adjacent to them.

To do this, we used four chainfalls suspended from the existing structure to support the upper stack section and silencer while the old slide valve section was being removed and while the new one was being installed. The 7-ft. diameter by 22-ft. long, 18,000-lb. silencer was not a part of the original equipment but was installed during a short shut-down at a later date to eliminate high-frequency noise caused by discharging of the flue gas. (The silencer is shown being installed on p. 82).

ONE OF THE TOUGHEST JOBS was installing this 7 x 22-ft., 9-ton silencer in position on the cat cracker (see also p. 84)

6 Troubles in the Catalyst U-Bends

A PROBLEM of catalyst erosion in the U-bend transfer lines, like the regenerator cyclone problem, was one that had to be handled in several phases. First, we made temporary repairs, and finally we replaced the lines entirely.

Because of the small diameter of these lines—they were both 18 in. O.D. by 43 ft. long—they were designed with ½-in. wall thickness and no refractory linings. As expected, we had difficulty with erosion around the aeration points and had to repair the lines three different times during the two years of operation prior to the major turnaround.

Phase 1—Temporary Repairs

These repairs were in the form of welded boots at the affected areas. Two of the failures were in the downflow section of the spent catalyst bend: the other failure was located almost at the lowest point and on the bottom of the regenerated catalyst bend.

All three of the repairs were made while the unit was in full operation and without cutting the feed out of the reactor. Onstream repairs of this type require a great deal of skill and technique and should not be attempted without full knowledge of all problems involved. The work is hazardous and could cause serious damage to the unit as well as injury to personnel.

The drawing on the opposite page shows how the boots were attached.

Phase 2—Installing New Lines

We were able to fit the job of replacing these U-bends into the main schedule of work on the major turnaround.

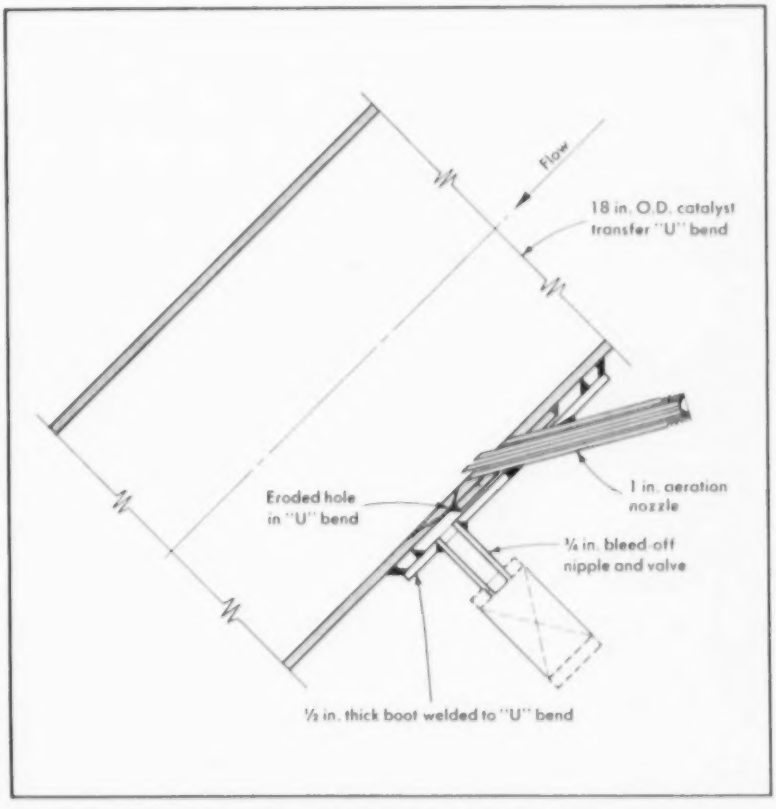
Before the unit was shut down, we decided that it would be more practical to replace both "U" bends with new ones of the same design than it would be to try to make tedious, time-consuming, permanent repairs to the old bends in place.

We also felt that better repairs could be made and closer inspection given with the bends in a horizontal position than could be made in the operating position because of the restricted space.

It was after this decision that new bends were purchased and installed during the turnaround. This task proved relatively simple and required much less time than would have been consumed had the old ones been repaired in place.

The old bends will now be inspected and rebuilt by patching localized eroded areas and by completely replacing with new pipe the sections where the erosion is more or less general.

The most trying parts of the repair work were the difficult chipping-out operation, and application of the final weld from inside the bend, with subsequent hand-grinding to make it smooth enough to prevent further erosion.


Flow
18 in. O.D. catalyst transfer "U" bend
1 in. aeration nozzle
Eroded hole in "U" bend
¼ in. bleed-off nipple and valve
½ in. thick boot welded to "U" bend

HOW REPAIRS WERE MADE WHILE UNIT WAS ONSTREAM—by the use of welded boots, holes were plugged in the catalyst U bends

Performance Meets Pre-Shutdown Estimates

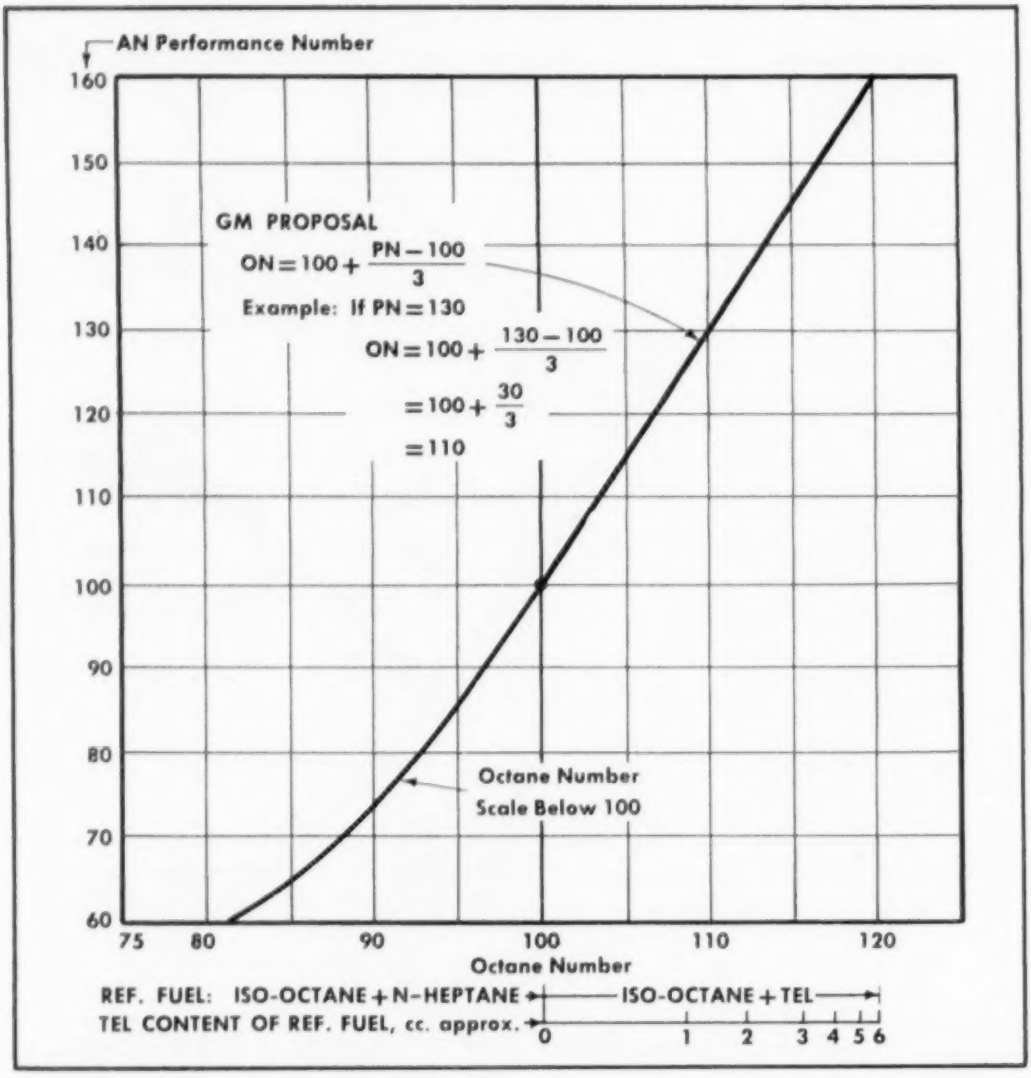
The off-stream portion of the turnaround was completed and the units turned back to the operating department, ready to start up at 8:00 p.m. on the twenty-first day, which was in accordance with the predictions made at the pre-shutdown planning meeting three weeks prior to the shutdown.

The final tabulation of craft labor used before, during and after the twenty-one-day shutdown period is shown in the table. It compares very favorably with the original estimates. This job was the largest, and is considered to be one of the best-planned and executed turnarounds in the history of the refinery.

The cracking unit is now operating with a catalyst consumption of approximately one t/d, based on a 50-50 ratio of fresh feed/recycle charge of 10,500 b/d with a conversion of 73% and with less than 350 b/d fuel oil make.

Distribution of Man Hours Before, During, and After Twenty-one Day Shutdown

Crafts	Before Shutdown	During Shutdown	After Shutdown	Total
Boilermakers and Riggers	532	4,496	157	5,185
Bricklayers	—	333	36	369
Carpenters	41	1,131	63	1,235
Insulators	12	633	360	1,005
Heavy Equipment Operators	20	551	6	577
Laborers	—	1,752	300	2,052
Painters	—	799	645	1,444
Pipefitters	246	2,688	103	3,037
Mechanics	—	1,033	69	1,102
Machinists	534	1,939	61	2,534
Pipe Machine Operator	29	289	15	333
Sheet Metal Worker	—	384	104	488
Truck Drivers	84	660	36	780
Instrument Repairmen	—	466	15	481
Electricians	—	416	1	417
Salvage Shop Mechanics	—	340	24	364
Blacksmith	6	154	7	167
Total Man Hours	1,504	18,064	2,002	21,570



EXTENSION OF THE OCTANE SCALE above 100 could be achieved with a conversion formula proposed by General Motors, which would relate AN Performance Number to octane rating.

Proposed Scale Can . . .

Rate Motor Fuels to 120 Octane

By V. B. GUTHRIE
Associate Editor

A NEW SCALE for expressing motor fuel antiknock values above the present 100 octane limit, but still in terms of octane numbers, has been developed by technical groups of the petroleum and automotive industries.

The proposed rating method stems originally from a General Motors Research Corp. procedure. It uses tetraethyl lead in isooctane as a reference fuel—the same reference fuel used in measuring knock characteristics of aviation fuels. The test results, expressed in performance numbers, are then converted to an octane number by this formula:

$$ON = 100 + \frac{PN - 100}{3}$$

The proposed scale calls for no change in expressing antiknock values below 100 octane, and the break at 100 in shifting to the new scale is relatively small. Actual testing of fuels can be done in the standard CFR laboratory test engine, using the presently accepted ASTM Research or Motor Methods for evaluating motor fuels.

In practical application, the amount of TEL in the reference fuel (from 0 to 6 cc.) could be expressed directly in octane numbers (from 100 to 120)

by means of a conversion table. With this table, use of the conversion formula in individual tests would be avoided, and a ready scale of octane numbers over 100 based on the TEL content of the reference fuel would be provided.

The following unofficial conversions from isooctane plus TEL to octane numbers are approximations, based on the existing ASTM table for converting isooctane plus TEL to performance numbers, and applying the proposed formula:

Isooctane plus cc. of TEL	Proposed Octane Number
0	100
1	108.6
2	112.8
3	115.5
4	117.5
5	119.1
6	120.3

Key factor in the formula for converting performance number above 100 to octane number in this range is the relationship between aviation engine antiknock performance and motor car engine performance. The rate of increase in motor car engine performance above 100 has been taken as a third of the increase in aviation engine performance. This ratio recognizes the smaller performance gains with given increments of TEL in isooctane for the average motor car engine, through increased compression ratios, as compared with an aviation engine, where supercharging boosts power.

Who Did the Work

Developing a procedure for rating antiknock values for motor fuels above 100 octane has been in the hands of two scientific agencies—the Coordinating Research Council and the American Society for Testing Materials. The CRC is the joint research agency of the American Petroleum Institute and the Society of Automotive Engineers. Its studies were carried out through its Cooperative Fuels Research Committee. ASTM's Committee D-2 on Petroleum Products and Lubricants carried out that agency's studies through its Research Division 1 on Combustion Characteristics.

The CRC committee under chairman T. B. Rendel, Shell Oil Co., turned over to Research Division 1 of ASTM Committee D-2 the development work on the project, because this latter group, by definition, handles matters relating to the CRF antiknock test engine. Chairman of Research Division 1 is F. C. Burk, Atlantic Refining Co. Philadelphia. The CRF also carried on studies, because it is primarily interested in the relationship of the CRF test engine to automotive engines in service. The personnel of the two groups is about the same and includes representatives of both the petroleum and automobile industries. The new scale proposed is the joint work of the two groups.

The Study Procedure

In starting its work, Research Division 1 reviewed various proposals for extending the antiknock scale above 100 and set up four premises which the members felt any new scale should satisfy:

1—The present octane scale below 100 should be maintained.

2—The octane scale below 100 should continue to be defined in terms of normal heptane and isooctane. The scale above 100 should be defined in terms of isooctane and TEL.

3—The octane scale extension should have a definite relationship to engine performance in the region above 100 and each number above 100 should represent approximately the same change in antiknock quality.

4—The octane number scale extension should be continuous with the octane scale in the region of 100.

There was practically unanimous agreement that the units of the scale above 100 should be called octane numbers.

The study groups first considered the two antiknock rating scales that CRC a few years ago had proposed for trial by industry. These were a performance number scale and an octane scale represented by the formula $ON = 128 - (2800/PN)$, which is the formula used to relate octane numbers to performance numbers below 100 octane. Examination of the CRC scales with regard to the four basic premises outlined above indicated that neither would meet all four of the conditions.

The CRC performance number scale did not tie in with the present octane scale below 100. If the performance scale were adopted only for ratings above 100, it would mean a break in the scale at the 100-point. The CRC octane number scale as proposed failed to meet the provision that each number above 100 should represent approximately the same change in antiknock quality.

Several scales proposed by oil companies were examined by the study groups. Some could be related to octane numbers above 100 by calibrating the reference fuel components and their blends against isooctane-normal heptane and isooctane-plus-TEL in a given engine under certain operating conditions. Octane numbers would be assigned on the basis of the blends of the reference fuels. It was felt that these methods called for procedures that would not be too difficult to use in standard laboratory engines, but that they would be out of the question in full-scale, multi-cylinder engines under the many different operating conditions possible.

Other tests proposed were set aside because they called for a very high antiknock reference fuel which would not be available in the quantities necessary for widely distributed test work. Some methods suggested, the study groups felt, required cooperative laboratory testing before they could be considered for general use.

Wiese Scale Selected

The Wiese (General Motors) formula for converting *PN* into *ON* was selected for further study because it was believed it could be adjusted to meet the requirements of the four basic premises. This formula: was

$$ON = 100 + \frac{PN - 100}{3}$$

developed by Warren M. Wiese, Fuels and Lubes Dept., General Motors Research Corp., Detroit. It is based on the principle that the rate of increase in engine antiknock performance over 100 octane in an automotive engine is one third that in an aviation engine.

The Wiese scale is not strictly continuous at 100 with the lower octane scale, because the extension is based on the average size of octane numbers between 95 and 100 on the basis of their *PN* values. Because the difference in *PN* between 99 and 100 is greater than the average difference, a slight discontinuity exists at 100 octane number, but the difference is so small that it was not regarded of practical concern.

The Wiese formula was also considered as satisfying the third premise because each performance number from 100 to 160 represented, for all practical purposes, an equivalent change in engine performance.

The chief objection to the Wiese method was that the *PN* scale was required to get the octane values for the various increments of TEL. To overcome this, a mathematical equation was devised for putting the *PN* readings above 100 octane into octane numbers. In actual practice, this equation will not be required because tables

can be prepared to convert the ccs. of TEL in isooctane into octane numbers above 100.

Some Objections Voiced

Work on the proposed new antiknock scale at the higher levels was completed last summer. In October the proposal was submitted by the study groups to the full membership of Committee D-2's Research Division 1 and the Cooperative Fuels Research Committee of CRC. About 30% of the ballots returned failed to endorse the new technique.

The chief objection voiced by dissenters is the discrepancy, at the higher octane levels, between the degree of improved antinock performance built into the engine and the numerical values assigned the fuel, as compared with ratings at lower octane levels.

"The disadvantage of the logarithmic nature of the octane scale was not apparent until motor fuels in the range of 90-100 octane numbers were marketed," one refinery representative stated. "Experience with these modern fuels has pin-pointed that large increases in antiknock quality are credited with small numerical increases as a result of the logarithmic nature of the rating scale.

"It is difficult to convey the significance of this situation to the public, especially because it is difficult to name counterparts—where the quality scale of a manufactured commodity is logarithmic. The customer, therefore, does not, and cannot, be easily educated to appreciate the increase in quality which one "octane number" represents. In other words, to laymen the numbers between 90 and 100 are unrealistic when compared to previous, conventional terminology.

"Our main objections to the proposed scale extension are as follows:

"1—For continuity it uses a large increment, extracted from the objectional upper end of the present scale.

"2—It is not supported by technical data to relate it to engine performance.

"3—It does not provide for statistically significant averaging of results above and below 100.

"It must be conceded, too, that the octane number scale ends at 100 and any numerical extension of it is as arbitrary as it is empirical.

"The 120 value assigned to the upper limit by the formula (proposed) therefore is considered an arbitrary value favoring the motor industry in that substantial increases in antiknock quality requirement can be built into the engine, while that industry admits only slight numerical increases in antiknock values assigned the fuels.

"The refiner, on the other hand, will be put to great expense to meet these 'slight' numerical increases and will find it difficult to explain why so little costs so much."

"If it is conceded that it is expensive to produce fuels in the range above 100, then this alone justifies assigning numerical values commensurate with past conceptions of increasing quality. If such incremental increases in antiknock quality are as valuable to the motor industry and consumers as they are expensive to the refiner, then this fact, likewise, supports the argument that the logarithmic nature of the scale should be abandoned."

"The scale as currently proposed will provide only temporary relief," commented another refiner on the proposal for a new scale. "Once the 1 cc. of TEL/gal. is reached, the octane number improvement in fuel for additional amounts of TEL, or the refining process required to obtain the same result, becomes insignificant. One cc. TEL/gal. gives an 8.6 octane number improvement, whereas an additional 5 ccs. TEL/gal. permits an increase in fuel quality of only 11.7 octane numbers."

Another refiner pointed out the discontinuity with the lower scale existing at 100 octane, because the size of the octane numbers above 100 has been arbitrarily set to be equivalent on a *PN* basis to the size of the octane numbers between 97 and 98. "More important than that," he stated, "is the fact that even at this level we have set a size of number that is much larger than industry has had experience with, and upon which our economics are based."

The same refiner also stated that the decision to maintain the present octane scale below 100 eliminated consideration of many scales of considerable merit. "The claim that we cannot change the octane numbers below 100 is hardly justified in view of the fact that we did just that when we went from Motor to Research in our commercial usage."

Other negative comment on the new scale voiced concern over the possibility of confusion resulting from the use of two scales, octane numbers and performance numbers, for rating motor fuels above 100 octane. "Supporting data has not been furnished to indicate that this formula describes octane quality above 100 any better than the present CRC scale or performance number," was the comment of another refiner. "Because the industry is already committed to a scale for aviation gasolines above 100, the need to further complicate the situation with separate scales for motor and aviation gasolines is questionable."

New Scale Is Montreal Meeting Topic

THE PROPOSED method for rating antiknock values above 100 octane is to be presented to refiners May 16, during the annual meeting of the American Petroleum Institute Refining Division in Montreal. The forum will be a joint meeting of the Division's Committees on Petroleum Products and on Automotive Research. It is scheduled for 9 a.m.

Speakers will include T. B. Rendel, Shell Oil Co., New York, chairman of the Cooperative Fuels Research Committee of the Coordinating Research Council. Mr. Rendel headed the project for developing the extension of the antiknock rating scale. Other speakers will be L. W. Moore, executive vice president, American Oil Co., New York, and B. B. Turner, executive vice president, Ethyl Corp., New York. C. C. Tate, Phillips Petroleum Co., Bartlesville, will preside.

Warren M. Wiese, Fuels and Lube Dept., General Motors Research Corp., Detroit, was programmed to present a paper on the new proposed antiknock scale April 20, at the meeting of the National Petroleum Assn. in Cleveland. His paper, discussing the problem from the point of view of the automobile manufacturers, was titled, "Consideration of a Practical Extension of the Octane Scale." Added significance attends his presentation, because the Wiese (General Motors) formula for arriving at octane numbers above 100 is the basis for the new scale proposed to the petroleum and automotive industries.

Petroleum Processing's 1956 Report on the

API Division of Refining

For Our Mutual Benefit

W. T. GUNN
Director, Refining Division

E. B. McCONNELL
Vice President for Refining

ONE of the objectives of the American Petroleum Institute is to "promote the mutual improvement of its members and the study of the arts and sciences connected with the petroleum industry."

The program and activities of the Division of Refining are designed to meet that objective. The work of our committees, the papers presented at our open sessions, and the informal exchange of information at our meetings all serve to promote the art of refining and the solution of some technical and operating problems that are non-competitive. Thus, by all of us doing a better job as refiners, we are not only providing better service and better products to our customers but we are also helping the industry conduct its operations with a sincere regard for the safety and welfare of our employees and our neighbors.

A glance at the program of our 21st Mid-Year Meeting this May should convince anyone that my statement is correct. The breadth and quality of the papers to be presented, and the importance of the problems our committees will discuss, make this meeting a "must" for all refiners.

I am especially happy to have this meeting in Montreal. During recent years, Canadian refiners have taken a great interest in the Institute, and their active participation in the Division of Refining has given us a very valuable new source of strength.

Our two countries have many common problems. The friendly relations established through these contacts will serve to promote a better mutual understanding of those problems and at the same time bring a fresh point of view to refiners on both sides of the border working toward the advancement of the refining art.

About thirty years ago, I made several trips across Canada from Montreal to Vancouver, and was deeply impressed by the basic strength that lay in the country's natural resources and the industry of its people. Nor shall I ever forget the cordial hospitality and kind consideration I received from my hosts. I am looking forward with great pleasure to another visit and hope to renew old acquaintances at Montreal May 14-17.

E. B. McConnell

E. B. McCONNELL
API Vice President for Refining

Here's What You'll Find in this Special API Section

THIS special 16-page section is devoted to the API Division of Refining. Its target is to give you a close-up on what the Division does, the activities of its many committees, and some idea of what you will hear discussed at the Mid-year meeting in Montreal this month. This is what you'll find:

• **Message from E. B. McConnell,** vice president for refining and chairman of the General Committee of the Division this page

• **Complete program**—listing all papers scheduled for each session and the various committee meetings. You'll also find two helpful guides: a "timetable" telling what is happening, at what time, on what day, and where, and 2) an alphabetical list of committee meetings (by subject) with time, date, and location p. 94

• **The Montreal Hosts**—a story with pictures of the 13-man Canadian subcommittee that has spent many months preparing for you p. 98

• **Where Should Electrical Equipment Be Installed**—the story behind the story of one of the group sessions at Montreal, which will be a panel discussion of RP-500, the API Recommended Practice for the Classification of Refinery Areas for the Installation of Electric Equipment p. 100

• **Committee Reports**—The eighth annual roundup by PETROLEUM PROCESSING of the reviews by chairmen of the Division's seven technical committees p. 102

21st Mid-Year Meeting
American Petroleum Institute
DIVISION OF REFINING
May 14-17, 1956
Montreal, Que.

Mid-Year Meeting Program

What you'll hear during the Montreal meeting

TODAY'S problems discussed today—this could well be the slogan for the API Refining Division at any time. But it is underscored emphatically by the line-up of papers and discussions scheduled for the 21st Mid-Year Meeting of the Division in Montreal, May 14-17.

Take a look at some of the subjects high-lighted from the program:

- Corrosion problems resulting from distillation of Middle East crudes.
- Electrical equipment installation under the new API Recommended Practice RP-500.
- Trace analysis—a seven-paper symposium on analytical research.
- Trends in refinery instrumentation.
- Application for computers—in design, in engineering, in plant operation, and in planning.
- The problem of making fuels of 95-plus octane numbers.

These are only the highlights. There will be 13 group sessions comprising 50 technical papers, and there will be 45 meeting sessions of the various Refining Division committees.

Some of the committees are planning some unusual and interesting activities during their meetings. We recommend you check with members of the various committees in which you are interested to obtain further details. Also, it will be wise to check on whether such meetings are to be open or closed door sessions. Such decisions are left to the discretion of the chairmen and might possibly be last-minute decisions due to inadequate space or other reasons.

The guest speaker at the Open Dinner Session, on Wednesday, May 16, will be the Hon. Lester B. Pearson, Secretary of State for External Affairs, Dominion of Canada. This dinner meeting will also include an address by Frank M. Porter, president of the API, and a presentation of the API "Certificate of Appreciation."

Details of the complete program follow on this and the next page. For the handy guide to committee meetings and the timetable to all activities, please turn to the following two pages.

ANALYTICAL RESEARCH

Monday, May 14, 9:00 a.m., Ball Room.

Presiding: G. R. Lake, Union Oil Co. of California. (Session developed by Mr. Lake and C. E. Headington, Atlantic Refining Co.)

Spectrophotometric Determination of Chloride, Bromide and Iodide, by F. W. Chapman, Jr., and R. M. Sherwood, Atlantic Refining Co.

Determination of Trace Amounts of Arsenic in Petroleum Distillates, by N. C. Maranowski, R. E. Synder, and R. O. Clark, Gulf Research and Development Co.

Determination of Trace Amounts of Total Nitrogen in Petroleum Distillates, by G. R. Bond, Jr., and C. G. Harriz, Houdry Process Corp.

X-Ray Absorption Edge Spectroscopy as an Analytical Tool: Determination of Molybdenum and Zinc, by R. E. Barieau, California Research Corp.

Determination of Trace Amounts of Lead in Gasolines and Naphthas, by Margaret E. Griffing, Adele Rozek, L. J. Snyder, and S. R. Henderson, Ethyl Corp.

Determination of Water in Methane and Ethanethiol, by G. Matsuyama, Union Oil Co. of California.

Determination of Trace Amounts of Carbon Monoxide in Gaseous Hydrocarbons, K. H. Nelson, M. D. Grimes, D. E. Smith, and B. J. Heinrich, Phillips Petroleum Co.

Afternoon session, 2:00 p.m., Ball Room.

Presiding: C. H. Caesar, Imperial Oil Ltd.

Application of Vapor Phase Chromatography to the Analysis of Liquid Petroleum Fractions, by D. H. Desty and B. H. F. Whyman, British Petroleum Co.

Quantitative Analysis of Organic Disulfides, by Rethel Hubbard, W. E. Haines, and J. S. Ball, U.S. Bureau of Mines.

Determination of Fuel Oil Stability by Optical Density Measurements, by W. H. Armstrong, D. Milsom, H. P. Herbert, and A. R. Rescorla, Cities Service Research and Development Co.

A Rapid, Precise Micro Vapor Pressure Method, by A. Y. Mottlau, Esso Research and Engineering Co.

Combustion and E.D.T.A. Titrimetric Determination of Total Sulfur in Petroleum Products, O. N. Hinsvark and F. J. O'Hara, Girdler Corp.

Fluorescent X-Ray Spectral Analysis of Powdered Solids by Matrix Dilution, by E. L. Gunn, Humble Oil & Refining Co.

Determination of Calcium or Zinc Additives in Lubricating Oils and Concentrates by an E.D.T.A. Titration Method, by P. B. Gerhardt and E. R. Hartmann, Esso Research and Engineering Co.

CORROSION

Monday, May 14, 9:00 a.m., Champlain Room.

Presiding: G. L. MacPherson, Imperial Oil Ltd. (Session developed by C. F. Pogacar, Atlantic Refining Co.)

Painting of Steel Structures in Petroleum Refineries, by Joseph Bigos, Steel Structures Painting Council, Mellon Institute, and J. O. Jackson, Pittsburgh-Des Moines Steel Co.

Corrosion in Distilling and Vacuum Distilling Units for the Processing of Middle East Crude Oil, by W. A. Derungs, N. V. de Bataafsche Petroleum MIJ.

How Richfield Plans to Combat High-Temperature Sulfide Corrosion in Their New Catalytic Reformer, B. W. Neumaier and C. M. Schillmoller, Richfield Oil Corp.

High-Temperature Hydrogen Sulfide Corrosion in Commercial Sovaformer Units, by E. B. Backensto and R. D. Drew, Socony Mobil Laboratories, and J. N. Vlachos, Socony Mobil Oil Co.

Effects of Graphitization on the Stress-Rupture Properties of Welded and Unwelded Plain-Carbon Steels (Summary Report of the Subgroup on Deterioration of Steels, Subcommittee on Unfired Pressure Vessels, Committee on Refinery Equipment), by J. G. Wilson, Shell Oil Co.

ELECTRICAL EQUIPMENT

Monday, May 14, 2:00 p.m., Champlain Room.

Presiding: D. L. Campbell, British American Oil Co. Ltd. (Session developed by K. N. Thompson, Socony Mobil Oil Co.)

A Refiner's Experience in Using API Standard RP-500, by F. C. Somers, Atlantic Refining Co.

Engineering Contractor's Reaction to RP-500, by J. T. Pringle, Bechtel Corp.

Problems in Providing Suitable Electrical Equipment for Class 1, Division 2 Areas, by Earle R. Hoyle, Sinclair Refining Co.

Differences Between Canadian and American Refinery Electrical Practices. K. L. Bellamy, Hydro-Electric Power Commission of Ontario.

INSTRUMENTATION

Tuesday, May 15, 9:00 a.m., Ball Room.

Presiding: J. K. Jamieson, Imperial Oil Ltd. (Developed by G. N. Ehly, Atlantic Refining Co.)

Service of the ISA to the Petroleum Industry, by Robert T. Sheen, president, Instrument Society of America.

Instrumentation of Petroleum Processes, by James G. Kerley, Shell Oil Co.

Information for Plant Management, by Albert F. Sperry, Panellit, Inc.

Automatic Process Stream Analyzers, by Thomas C. Wherry, Phillips Petroleum Co.

FUELS AND LUBRICANTS

Tuesday, May 15, 9:00 a.m., Champlain Room.

Presiding: G. Davidson, Shell Oil Co. of Canada. (Developed by T. B. Rendel, Shell Oil Co.)

Practical Design of Better Fuels—A Statistical Approach to Road Performance Studies, by F. D. Buerstetta and W. D. Healy, Jr., Ethyl Corp., and E. E. Sorenson and W. J. McGuire, British American Oil Co.

COMPUTERS

Tuesday, May 15, 2:00 p.m., Champlain Room.

Presiding: A. G. Farquharson, McColl-Frontenac Oil Co. Ltd. (Developed by C. L. Thomas, Sun Oil Co.)

The Use of Computers in Petroleum Refining Problems, by Jack Sherman, The Texas Co.

Calculation of the Equilibrium Composition of C_n Hydrocarbon-Hydrogen Systems, by Edward B. Weinberger and C. W. Montgomery, Gulf Research & Development Co.

Growth of a Technical Computing Activity, by T. H. Green, Jr., and C. M. Jones, Shell Oil Co.

Design of Heat Exchangers on Automatic Computing Equipment, by A. M. Peiser, M. W. Kellogg Co.

Solution of Multicomponent Distillation Problems on a Stored Program Computer, by J. S. Bonner, Humble Oil & Refining Co.

Computers in Refinery Planning, by Robert G. Donovan and Robert W. Schrage, Esso Standard Oil Co.

REFINERY MAINTENANCE

Tuesday, May 15, 2:00 p.m., Ball Room.

Presiding: Gordon R. Henderson, Sun Oil Co. Ltd. (Developed by D. R. Johnson, Continental Oil Co.)

Scope and Administration of Preventive Maintenance, by C. C. Carmine, Tide Water Association Oil Co.

Development of Cost Yardsticks, by E. S. Bale, Standard Oil Co. (Ohio).

PROCESSES

Tuesday, May 15, 7:30 p.m. "95-Plus Octane Numbers," Ball Room.

Presiding: Charles Hay, Royalite Oil Co., Ltd. (Developed by C. L. Thomas, Sun Oil Co.)

Catforming for High Octanes in Canada, by H. R. Grane and J. A. Nevison, Atlantic Refining Co.

Commercial Two-Stage Fluid Cracking—A New Technique, by J. D. Heldman, F. Kunreuther, J. A. Marshall, and C. A. Rehbein, Shell Oil Co.

Ultraforming to 100 Octane Clear, by W. F. Johnstone, W. J. Montgomery, and P. C. White, American Oil Co.

Platforming—A Progress Report, by Vladimir Haensel and D. H. Belden, Universal Oil Products Co.

SMOKE AND FUMES

Wednesday, May 16, 9:00 a.m., Ball Room.

Presiding: John W. Newton, Magnolia Petroleum Co. (Developed by W. H. Claussen, California Research Corp.)

Review of the Smoke and Fumes Committee Research Program, by L. C. Kemp, Jr., The Texas Co.

Recent Developments in the Study of the Organic Chemistry of the Atmosphere, by W. E. Scott, E. R. Stephens, Philip L. Hanst, and Robert C. Doerr, Franklin Institute.

Panel Discussion: The Refiners Approach to Pollution Control. Panelists: E. B. McConnell, Standard Oil Co. (Ohio); H. G. Osborn, Continental Oil Co.; H. W. Ferguson, Humble Oil & Refining Co.; and G. S. Dunham, Socony Mobil Oil Co. Moderator: John W. Newton.

WASTE DISPOSAL

Wednesday, May 16, 2:00 p.m., Ball Room.

Presiding: John R. Patton, Regent Refining (Canada) Ltd. (Developed by W. F. Meehan, Standard Oil Co.-Ind.)

Air Oxidation of Sulfides in Refinery Process Waters and Caustic Solutions, by A. G. Smith, Shell Oil Co.

Biological Oxidation of Petroleum Phenolic Waste Water, by Alan A. Sheppard, William K. Ross, and Alex D. McRae, Imperial Oil Ltd.

The Diatometer—A Method for Indicating the Conditions of Aquatic Life, by Ruth Patrick and Matthew H. Hohn, Philadelphia Academy of Natural Sciences.

Biological Oxidation and Re-Use of Refinery Waste Water for Pollution Control and Water Conservation, by Harold F. Elkin, Sun Oil Co.

Waste Disposal in Retrospect, by W. B. Hart, Pantech, Inc.

OPEN DINNER SESSION

Wednesday, May 16, 7:00 p.m., Ball Room.

Presiding: E. B. McConnell, API Vice-President for Refining, and Standard Oil of Ohio. (Developed by D. L. Campbell, British American Oil Co. Ltd.)

Opening Remarks: E. B. McConnell.

Presentation of API Certificates of Appreciation to A. J. Ely, Esso Research and Engineering Co.; J. B. Rather, Sr., formerly of Socony Vacuum Oil Co.; Harry Levin, The Texas Co.; and C. E. Davis, formerly of Shell Oil Co.

Address: Frank M. Porter, president, API.

Address: Hon. Lester B. Pearson, Canadian Secretary of State for External Affairs.

TRAINING

Thursday, May 17, 9:00 a.m., Ball Room.

Presiding: W. Harold Rea, Canadian Oil Companies Ltd. (Developed by R. R. Faller, Ethyl Corp.)

Developing Engineers in the Field of Refinery Technology, by Dwight S. Simmons, Imperial Oil Ltd.

The Liberal Arts in Executive Development, by J. Roby Kidd, Canadian Assn. for Adult Education.

The Line Manager's Role in Supervisory Development, by G. Davidson, Shell Oil Co. of Canada Ltd.

Your Guide to the Committee Meetings

DATE	9:00 A.M.	2:00 P.M.
THUR. MAY 10	Corrosion Subcomm., panel on Cat-Reforming Corrosion, Salon C Joint Meeting: Mechanical Equipment Subcomm. & Mfgrs. Subcomm. on Centrifugal Compressors, Brittany Room Mfgrs. Subcomm. on Refinery Valves, Salon D Oil-Water Separation Subcomm., Salon E	Waste Gases and Dusts Subcomm., Salon E Sludges and Spent Clays Subcomm., Salon C Joint Meeting: Mechanical Equipment Subcomm. & Mfgrs. Subcomm. on Centrifugal Compressors, Brittany Room Mfgrs. Subcomm. on Refinery Valves, Salon D
FRI. MAY 11	Corrosion Subcomm., Salon D Joint Meeting: Mechanical Equipment Subcomm. & Mfgrs. Subcomm. on Centrifugal Compressors, Brittany Room Analytical Research Comm., Salon L Mfgrs. Subcomm. on Safety and Relief Valves, Salon F Chemical Wastes Subcomm., Salon E	Corrosion Subcomm., Salon D Pressure-Relieving Systems Subcomm., Salon E Sampling and Testing Subcomm., Salon F Joint Meeting: Mechanical Equipment Subcomm. & Mfgrs. Subcomm. on Mechanical Drive Turbines, Brittany Room Oil-Water Separation Subcomm., panel on Separation Vapor Losses, Salon C Analytical Research Comm., Salon L
SAT. MAY 12	Disposal of Refinery Wastes Comm., Brittany Room Joint Meeting: Mechanical Equipment Subcomm. & Mfgrs. Subcomm. on Mechanical Drive Turbines, Salon B Corrosion Subcomm., Salon K Analytical Research Comm., Salon D	Disposal of Refinery Wastes Comm., Brittany Room Joint Meeting: Mechanical Equipment Subcomm. & Mfgrs. Subcomm. on Mechanical Drive Turbines, Salon B Corrosion Subcomm., Salon K Analytical Research Comm., Salon D Electrical Equipment Subcomm., Salon K Low-Pressure Storage Tanks Subcomm., Salon L
SUN. MAY 13	Joint Meeting: Refinery Inspection Supervisors Subcomm. & Designers Subcomm. on Refinery Inspections, Brittany Room Piping and Valves Subcomm., Salon D Instruments Subcomm., Salon F	Joint Meeting: Refinery Inspection Supervisors Subcomm. & Designers Subcomm. on Refinery Inspections, Brittany Room Piping and Valves Subcomm., Salon D
MON. MAY 14	**Analytical Research Session, Ball Room** **Corrosion Session, Champlain Room** Training Comm., Salon K Petroleum Products Comm., Salon B Publications Comm., Salon F Electrical Equipment Subcomm., Salon D	**Analytical Research Session, Ball Room** **Electrical Equipment Session, Champlain Room** Unfired Pressure Vessels Subcomm., Salon D Tubing Subcomm., Salon E Technical Advisory Comm., Salon F Training Comm., Salon K
TUES. MAY 15	**Trends in Refinery Instrumentation Session, Ball Room** **Fuels and Lubricants Session, Champlain Room** Training Comm., Salon K Analytical Research Comm., Salon B	**Computer Session, Champlain Room** **Refinery Maintenance Session, Ball Room** Smoke and Fumes Comm., Salon D Automotive Research Comm., Salon J Executive Comm., (CRE) Salon F (4:00 p.m.) Training Comm., Salon K Analytical Research Comm., Salon B
WED. MAY 16	**Smoke and Fumes Session, Ball Room** Training Comm., Salon K Refinery Equipment Comm., Salon D Joint Meeting: Petroleum Products Comm. & Automotive Research Comm., Champlain Room	**Waste Disposal Session, Ball Room** General Comm., Salon D (1:45 p.m.) Advisory Comm., Salon F (3:00 p.m.) Training Comm., Salon K
THUR. MAY 17	**Training Session, Ball Room** Program Comm., Salon K Analytical Research Comm., Salon D	General Comm., Salon D

TUES. MAY 15 AT 7:30 P.M.	**Processes Session, Ball Room**	
WED. MAY 16 AT 7:00 P.M.	**Open Dinner Session, Ball Room**	**Heavy Type—Group Sessions**
THUR. MAY 17 AT NOON	General Committee Luncheon, Salon B	Light Type—Committee Meetings

Your Timetable to Sessions and Meetings

Subject	Chairman	Date	Time	Place
Advisory Committee	H. W. Ferguson	Wed. May 16	3:00 p.m.	Salon F
Analytical Research Committee	G. R. Lake	Fri. May 11	9:00 a.m.*	Salon L
	G. R. Lake	Sat. May 12	9:00 a.m.*	Salon D
	G. R. Lake	Tues. May 15	9:00 a.m.*	Salon B
	G. R. Lake	Thur. May 17	9:00 a.m.*	Salon D
Automotive Research Committee	W. J. Sweeney	Tues. May 15	2:00 p.m.	Salon J
Chemical Wastes Subcommittee	R. J. Austin	Fri. May 11	9:00 a.m.	Salon E
Corrosion Subcommittee	E. B. Backensto	Thur. May 10	9:00 a.m.	Salon C
	H. G. Mangelsdorf	Fri. May 11	9:00 a.m.*	Salon D
	H. G. Mangelsdorf	Sat. May 12	9:00 a.m.*	Salon K
Disposal of Refinery Wastes Committee	J. H. Easthagen	Sat. May 12	9:00 a.m.*	Brittany Rm.
Electrical Equipment Subcommittee	L. M. Goldsmith	Sat. May 12	2:00 p.m.	Salon K
	L. M. Goldsmith	Mon. May 14	9:00 a.m.	Salon D
Executive Committee (CRE)	R. H. Venn	Tues. May 15	4:00 p.m.	Salon F
General Committee	E. B. McConnell	Wed. May 16	1:45 p.m.	Salon D
	E. B. McConnell	Thur. May 17	12:00 noon	Salon B
	E. B. McConnell	Thur. May 17	2:00 p.m.	Salon D
Inspection Supervisors Subcommittee, joint meeting with: Designers Subcomm. on Refinery Inspection	W. K. Brown J. H. Rickerman	Sun. May 13	9:00 a.m.*	Brittany Rm.
Instruments Subcommittee	G. N. Ehly	Sun. May 13	9:00 a.m.	Salon F
Low-Pressure Storage Tanks Subcommittee	W. L. Bowler	Sat. May 12	2:00 p.m.	Salon L
Mechanical Equipment Subcommittee, joint meeting with: Mechanical Drive Turbine Mfgrs. Subcommittee	E. F. Voss R. C. Twombly	Fri. May 11 and Sat. May 12	2:00 p.m. 9:00 a.m.*	Brittany Rm. Salon B
Mechanical Equipment Subcommittee, joint meeting with: Centrifugal Compressors Mfgrs. Subcommittee	E. F. Voss T. P. Latimer	Thur. May 10 and Fri. May 11	9:00 a.m.* 9:00 a.m.	Brittany Rm. Brittany Rm.
Oil-Water Separation Subcommittee	H. F. Elkin	Thur. May 10	9:00 a.m.	Salon E
Panel on Separator Vapor Losses	H. F. Elkin	Fri. May 11	2:00 p.m.	Salon C
Petroleum Products Committee also, joint meeting with: Automotive Research Committee	R. C. Alden W. J. Sweeney	Mon. May 14 Wed. May 16	9:00 a.m. 9:00 a.m.	Salon B Champlain R.
Piping and Valves Subcommittee	J. P. Mooney	Sun. May 13	9:00 a.m.*	Salon D
Pressure-Relieving Systems Subcommittee	E. D. Underwood	Fri. May 11	2:00 p.m.	Salon E
Program Committee	L. W. Robbie	Thur. May 17	9:00 a.m.	Salon K
Publications Committee	V. N. Jenkins	Mon. May 14	9:00 a.m.	Salon F
Refinery Equipment Committee	R. H. Venn	Wed. May 16	9:00 a.m.	Salon D
Refinery Valves, Mfgrs. Subcommittee	W. P. Kliment	Thur. May 10	9:00 a.m.	Salon D
Safety and Relief Valves, Mfgrs. Subcommittee	L. P. Stillman	Fri. May 11	9:00 a.m.	Salon F
Sampling and Testing Subcommittee	L. Mittleman	Fri. May 11	2:00 p.m.	Salon F
Sludges and Spent Clays Subcommittee	J. A. Fowler	Thur. May 10	2:00 p.m.	Salon C
Smoke and Fumes Committee	J. W. Newton	Tues. May 15	2:00 p.m.	Salon D
Technical Advisory Committee	L. C. Kemp, Jr.	Mon. May 14	2:00 p.m.	Salon F
Training Committee	J. J. Stadtherr	Mon. May 14	9:00 a.m.*	Salon K
	J. J. Stadtherr	Tues. May 15	9:00 a.m.*	Salon K
	J. J. Stadtherr	Wed. May 16	9:00 a.m.*	Salon K
Tubing Subcommittee	L. G. Molique	Tues. May 15	2:00 p.m.	Salon E
Unfired Pressure Vessels Subcommittee	N. J. Rees	Mon. May 14	2:00 p.m.	Salon D
Water Gases and Dusts Subcommittee	W. H. Lang	Thur. May 10	2:00 p.m.	Salon E

*This session lasts a full day.

"Welcome to Montreal" . . .

THE "welcome mat" is out in Montreal, thanks to extensive preparations made by the Canadians.

The Canadian subcommittee shown on these two pages was formed when the Canadians who serve on the general committee of the Refining Division of the API felt that a local working group could best expedite preparatory work for the May meeting.

As a result, two or three additional representatives from each company were included with the original five members of the general committee.

The first meeting of the group was held in the middle of June, 1955, and the committee has held a meeting once a month ever since. A. G. Farquharson (see below) has been chairman.

Special jobs have been discussed, planned, and then handled by smaller groups of the Canadian subcommittee, either in Montreal or Toronto. These included contacts with the Montreal Tourist and Convention Bureau, the hotels, transportation companies, and checking the thousand-and-one details that have been a regular part of the month-to-month operations.

The committee has produced much general information, such as the brochure material and publicity that was distributed at the annual meeting last November of the API in San Francisco. It has sent special mailings to the West Coast and to southern Texas.

A women's entertainment group has been particularly busy planning activities for API wives and daughters.

The Canadian group has not been concerned with the normal program planning that the Refining Division itself handles, though it has acted in an advisory capacity. Its primary job has been to weave a good "welcome mat."

A. G. FARQUHARSON
Chairman

Vice president, refining, McColl-Frontenac Oil Co., Ltd., since 1952. Born in Dundas, Ont. B.S. in chemical and metallurgical engrg., Queen's University, 1930. Joined McColl, 1932, inspection laboratory. Has been construction superintendent, Toronto refinery superintendent, ass't mgr. and manager of refining dept. Director, Portland Pipe Line Corp., Montreal Pipe Line Co., Trans-Northern Pipe Line Co. Member, API Refining Division General Committee.

H. B. BARTON
Secretary

Supervisor, technical service, McColl-Frontenac Oil Co., Ltd. Born in Toronto, Ont. Educated at Parkdale Collegiate and University of Toronto, chemical engineering, 1930. With McColl since 1935, starting as assistant resident chemist at Toronto refinery. Went to Montreal refinery in same capacity, 1937. Had been chief chemist before present job. As secretary of the Canadian Conference subcommittee, Mr. Barton has played a big role in its work.

F. O. WALKLING
Treasurer

Manager, blending & packaging plant, Shell Oil Co. of Canada, Montreal, since 1954. Graduate of McMaster University, Hamilton, Ont., with B.S. and M.S. Joined Shell in 1944 as chemist at Toronto. He transferred to products process section of manufacturing dept. in 1945, then to Montreal refinery as a technologist in 1951. He was appointed assistant manager of the despatching dept. in 1953, and in the following year was named to his present position.

GEORGE DAVIDSON

Vice president, manufacturing, Shell Oil Co. of Canada, Ltd. Member of the Refining Division's general committee. Born in Scotland. Joined Shell in 1925 after graduation from University of Glasgow with B.S. Has held posts all over the world: refinery supt., Tampico, Mex.; manager, Aruba, N. W.I., Wood River, Ill.; ass't mgr., Stanlow, England; mfg. dept., United States. Then to Montreal East as refinery mgr. in 1951 and present job in 1955.

D. L. CAMPBELL

Vice president, manufacturing, British American Oil Co., Ltd. Member of Refining Division's general committee. Has played instrumental role in program and other arrangements for Montreal meeting. Through his efforts, the Hon. Lester Pearson, Canada's secretary of state, was obtained as speaker at May 16 dinner meeting. Joined B-A at Moose Jaw in 1934 after graduation from University of Saskatchewan with B.S. Named to present post in 1954.

. . . says Your Host Committee

W. HAROLD REA

President, Canadian Oil Cos., Ltd. Member of Refining Division's general committee, and enthusiastic booster for Montreal meeting. Born in Kincardine, Ont., 1907, and obtained a degree as chartered accountant in 1931. Joined Canadian Oil in 1933 as an internal auditor, and moved into sales in 1937. Served government in petroleum activities, 1942-45, and then returned to company as executive ass't to the president. Named president in 1949.

G. L. MacPHERSON

A director of Imperial Oil Co., Ltd., and a member of the Ref'g Division's general committee. Born in Markdale, Ont. Graduate of University of Toronto and veteran of Royal Naval Air Service. Began with Imperial in 1922 as draftsman. Attended M.I.T. for advanced study in refinery design in 1922. Became ass't chief engineer in 1937, chief engineer in 1943. Appointed general manager of refining dept. in 1949 and elected director of the company in 1954.

F. J. HIMBURY

Manager of the public relations department of Canadian Oil Cos., Ltd., Toronto, Ont. Mr. Himbury has provided extensive assistance to the Canadian meeting subcommittee in matters of general publicity for the Montreal meeting during the past year. He has been associated with Canadian Oil Cos. since 1939. In 1954 he was appointed assistant to the president of the company, and in January of this year he was promoted to his present position.

KENNETH A. WEST

Manager of manufacturing, Canadian Oil Cos., Ltd. A native of Edmonton, Alta. Received M.S. in chemistry, University of British Columbia, and Ph.D., in 1942 from McGill. Joined Canadian Oil in 1951, after nine years in the oil industry in U.S. and Canada, as chief process engineer. Named refinery production superintendent in 1952, and to present post in 1955. Dr. West is a member of many honorary and technical groups and a professional engineer.

BERNARD BROUILLET

Field representative at Montreal for Imperial Oil, Limited, public relations dept. Born in Montreal and a graduate of the School of Higher Commercial Studies. He received his B.S. degree from the University of Montreal. Formerly a reporter with *La Presse*, daily newspaper in Montreal. Before joining Imperial, he held other public relations jobs with Canadian National Railways, Canadian Industries, Ltd., and Editorial Associates, Ltd.

Mrs. MURIEL SMALL

No convention committee can be regarded as complete unless it has at least one able representative of the distaff side. Mrs. Small is secretary to the Quebec Division Manager of Imperial Oil Limited, and a native of Montreal. She is president and a charter member of the Desk & Derrick Club of Montreal, and a member of the Business & Professional Women's Club. Her assignment in the host committee is to work out entertainment plans for API ladies attending the meeting in May.

J. P. THIBERT

Sales promotion supervisor for British American Oil, Ltd.'s, eastern region marketing operations. Has been active on the subcommittee in a number of its phases. Handled arrangements for dispatching the extensive direct mail promotion program as well as serving with the planning group for the women's program for the May meeting. A graduate of Mt. St. Louis College, Mr. Thibert has been in various areas in B-A's marketing department.

J. H. YOCOM

Manager of the public relations department, British American Oil Co., he has worked on the Canadian subcommittee on promotion and publicity matters and has acted as liaison with the API Information Committee. Joined B-A in public relations in Jan., 1953, following a number of years on Canadian publications. Mr. Yocom received his B.A. and M.A. degrees from the University of Toronto, and a Ph.D. from the University of Ottawa, and was with the RCAF in the war.

Montreal Program Highlight

Installing Electrical Equipment?

Recommended Practice RP-500 will help you pick the proper equipment for specific areas

AN answer to this question: Where can electrical equipment be installed in a refinery?—has been in the hands of the petroleum processing industry since early in 1955.

It is in the form of a recommendation, developed over a number of years by the American Petroleum Institute, Division of Refining, Subcommittee on Electrical Equipment. This extensive work culminated in Recommended Practice RP-500, "Classification of Refinery Areas for Installation of Electrical Equipment."

What is the industry's reaction to RP-500 today after about a year of living with it?

To find some of the answers, a technical session was developed for the 21st Mid-Year Meeting at Montreal this month by K. N. Thompson of Socony Mobil Oil Co., who is a member of the Subcommittee on Electrical Equipment. Scheduled for Monday, May 14, at 2:00 p.m., this session will bring together the viewpoints of a refiner, an engineering contractor, an equipment manufacturer, and a Canadian electrical engineer. (See program, pp. 96-97, for details.)

Why is this session at the Montreal meeting so important?

For answers to this, we had a talk with Kay Thompson.

"In the first place, it is highly controversial. It involves both safety and expensive equipment," Kay explained. "Our electrical equipment subcommittee has been wrestling with it since 1948. We were trying to find out just which areas may be made hazardous by flammable vapors.

"We've surveyed enough company practices to find that they have varied all over the lot. However, surprisingly enough, not many accidents have occurred, and most that did resulted apparently from human errors. People don't like to talk about these though, so we may not have all the data."

"In other words, Kay, the hazard angle may well be greater than we have factual data on, simply because of the human reluctance to report on such things? Then what about this business of expense?"

"Obviously," replied Kay, "many of us have been spending too much money on needless cast iron boxes which limit our access to equipment for maintenance purposes. But, of course, you do have to be conservative where volatile hydrocarbons are processed at high flow rates, high temperatures, and high pressures.

"The very upset that blows a gasket may also drastically change the composition of an oil. So, where and how shall we draw the line?—remembering that the use of electricity is growing rapidly today. These things call for good answers."

"Some of the answers are in RP-500?"

"Yes, our solution is in this API Recommended Practices RP-500, which was published in February, 1955," said Kay. "There are still many people who don't see eye to eye with us on it; maybe because they haven't read it but should do so soon.

"We hope the papers scheduled for presentation during the session on electrical equipment at Montreal will trigger a lively and thoughtful discussion. The subject of possibly flammable atmospheres has already evoked pointed comment from accident and fire prevention authorities, and there are also legal angles being considered."

"Your last comment, Kay, brings to mind one problem we've heard about —the potential danger that legal authorities might grab up RP-500 standards? Is this good or bad?"

"A good many folks worry about finding RP-500 in the legal codes which affect principally non-refinery installations," replied Kay. "A large part of this worry is needless. Refinery processing problems are different from marketing, for example, where products have definite properties. In a refinery, LPG and motor gasoline may exist in the same vessel, possibly with catalyst present, and at 500 psi. pressure and 1000°F. temperature."

"Well, that makes sense, Kay. Now, could you enlarge a bit on this economics angle? How can, or how does, RP-500 help?"

"Part of our high electrical costs come from the lack of a standard approach. It doesn't make much sense to work out the same problems differently each time for various companies and plants. RP-500 is easy to use. It will provide safe answers in most cases without extensive study. It will certainly cut down long-winded and costly company specifications.

"Manufacturers now can assess their market for equipment used in Class I areas. Perhaps oil company buyers will agree on standardized construction, which will cost less and be installed more readily."

"Kay, we've heard a lot recently about the British approach to electrical hazards. By that we mean the term 'intrinsic safety.' Can you comment on this?"

"Our British and Canadian friends believe that the safest electrical circuit is one which cannot deliver enough energy to a fault to cause a spark that will ignite anything. Anyone who has used an 'approved' flashlight knows that there is something to this argu-

ment, particularly when you consider the amount of energy normally used in a control or a signalling circuit. The National Electrical Code-Making Panel No. 14 is thinking about this right now.

"API's RP-500 certainly helps to define the areas where such circuits merit consideration. This is another point over which the discussion can become quite lively in a hurry."

"Sounds excellent, Kay. Now, what are some specific concrete results that RP-500 can help accomplish?"

"Well, it brings some new problems into the picture for one thing. Here's an example in a problem our committee is actively exploring right now: did you know that there are *no* industry standards for Class I, Division 2 electrical switchgear? We certainly miss these standards, because RP-500 classifies most outdoor refining areas as Division 2."

"And how about future trends in electrical or electronic equipment, Kay?"

"This is the way to look at that one. The Refining Division has scheduled two sessions at Montreal with a direct bearing on your question—one on computers, and another on control instrument trends.

"Certainly these costly and intricate installations won't be easy to cope with unless we have a good idea of our flammable vapor and Division 2 equipment problems. Instrument manufacturers frankly admit that they are 'flying blind' in this area of design."

Further Comments

Satisfied that Kay Thompson had solidified our understanding of the importance of his session at Montreal, we then went to some of the individual panel members themselves for some opinions.

An engineering contractor's viewpoint. Here is what J. T. Pringle, Bechtel Corp., San Francisco, Calif., has to say:

"Engineering is not an exact science and we cannot hope to make it so. But, its practice can be made more uniform and the results more consistent if we mark the way with guide posts.

"Often these guides are based on test results—the current rating of insulated wire, the output of a given type of lighting fixture, or the performance of a motor. But frequently, the only guide must be experience—either our own or that of a competent authority.

"Whether by edict or by choice, there is a general acceptance of the National Electrical Code as a basic authority on electrical installations. In the case of a refinery installation, it clearly specifies the types of equipment to be used in hazardous areas. In fact, it even breaks these areas into two divisions of differing degrees of hazard.

"But, if one points a finger at random to any spot in a refinery process area, only experience and judgment can decide the degree of hazard—if any—at this point.

"Experience indicates that if 10 different refinery operators or designers were asked to state the basis on which they classify a hazardous area for an electrical installation, there would be 10 answers—all differing from each other to some degree.

"To an engineering contractor this can be almost as confusing as if each of the 10 had a different method of rating insulated conductors or motor drivers. Not that there can be only one correct way to do such things, but rather that a uniform approach based on sound experience and good judgment should point out certain acceptable criteria.

"RP-500 seems to be what we have been looking for. Based on a study of certain fundamentals, plus the knowledge and experience of the authors, a logical series of steps was developed by which a refinery location can be classified. If this guide is followed, an engineering contractor can readily classify any area in a refinery and thus determine fairly positively the types of electrical equipment and the wiring methods to be used. Furthermore, any other engineering contractor, or any refinery operator, following RP-500 should reach essentially the same conclusions.

"In a sense, many talents have been pooled in arriving at this criterion of good practice. It is a tool that can be used to help remove some of the past inconsistencies from refinery electrical design. Because of local conditions peculiar to a given property, apparent inconsistencies will always exist. Yet, except for occasional limitations, the engineering contractor using this guide should find himself in tune with his client's wishes and in step with a recognized good practice.

"Those who have been concerned with the application of RP-500 have now had several months in which to consider its advantages and possible disadvantages. This session will provide an excellent opportunity for the presentation of different opinions, and for an evaluation of the degree to which the petroleum industry may follow this new guide."

An important step forward in standardization is the way the refining member of the Montreal session panel views RP-500. Earle R. Hoyle, Sinclair Refining Co., East Chicago, Ind., told us:

"This session is very important in view of the fact that the recently approved API Standard RP-500 opens the way for more economical use of electrical equipment within refineries, provided suitable electrical equipment for Division 2 can be obtained.

"The papers to be presented in the Montreal session cover the thinking of many people concerned with proper classification of areas and the equipment to be used in those areas.

"No doubt the discussions in the meeting will be very worthwhile. It will certainly bring out the thinking of the engineers and their practices in designing refinery installations.

"The session will be unique in that the thinking which has been brought out by RP-500 (which in itself is revolutionary) will do more to standardize electrical installations in refineries than any other standard or code available in the past."

The Developers of RP-500

The API Recommended Practice RP-500, discussed in this article, resulted from several years of work by the Refining Division Subcommittee on Electrical Equipment. The 1956 roster for this committee is:

Chairman: L. M. Goldsmith, Atlantic Refining Co.

Secretary: E. J. Nopper, Sun Oil Co.

P. H. Baker, Ohio Oil Co.

W. E. Highfill, Esso Research & Engrg. Co.

J. C. Howard, Standard Oil Co. (Indiana).

R. P. Howell, Standard Oil Co. of California.

E. R. Hoyle, Sinclair Refining Co.

W. V. Kaun, Cities Service Oil Co.

E. W. Kleinpeter, Ethyl Corp.

H. R. Schumacher, Richfield Oil Corp.

J. W. Shannon, Shell Oil Co.

T. R. Shaw, Phillips Petroleum Co.

F. C. Somers, Atlantic Refining Co.

H. M. Stewart, Humble Oil & Refining Co.

K. N. Thompson, Socony Mobil Oil Co.

A. E. Wolter, Pure Oil Co.

API Committee Reports

Useful Data Is Being Developed, —Do You Use It?

ARE you getting all you can out of the extensive work being carried on by the API Division of Refining? Are you completely aware of the many comprehensive technical studies being conducted by the Division's various subcommittees?

As a reader of PETROLEUM PROCESSING and as an individual technical man in the petroleum processing industries, you will find it pays to read the following reports, looking for committee activities that could provide you with helpful information.

Through the cooperation of the various subcommittee chairmen and W. T. Gunn, director of the Refining Division, we are able to bring you our seventh annual roundup report on API committee activities.

After you've studied the following discussions, find out who in your company is a member of the particular committee in which you are interested. Then make sure he sees that you get the data the committee develops. If you can't find anyone in your company on the committee, check with Bill Gunn at API Refining Division Office, RCA Bldg., New York City.

These Are the Industry Men Who Guide API's Refining Division

ELLIOTT B. McCONNELL
Chairman, General Committee

Vice president in charge of manufacturing and a director of Standard Oil Co. (Ohio), Mr. McConnell has been with the company 29 years. He worked first for Standard Oil of New Jersey after graduation from Cornell in 1923. He was born in Oil City, Pa., in 1901. In his second year now as vice president of the Refining Division, Mr. McConnell has also served the government, in the Petroleum Industry War Council and the Petroleum Administration for War.

L. W. ROBBIE
Chairman, Program Committee

A graduate of Armour Institute of Technology with a B.S. in chemical engineering in 1936, Mr. Robbie then spent 10 years in the engrg. dept. of Universal Oil Products Co., a number of years in foreign construction operations. In 1947, he became associated with Republic Oil Refining Co., Texas City, and is now vice president and general manager of refinery operations. He is also president and general manager of Duval Gasoline Co., a subsidiary of Republic.

HARRY W. FERGUSON
Chairman, Advisory Committee

Born in Mont Clare, Pa., in 1902, Mr. Ferguson received his B.S. in chemical engineering from Michigan in 1924. He then went to Humble Oil & Refining Co.'s development dept. at Baytown, Tex. In 1933, Mr. Ferguson was made assistant manager of technical and research work for refining, at Houston, and was made manager of the department and a member of the manufacturing committee in 1937. Since 1951, he has been a vice president of Humble.

Committee on Automotive Research

W. J. SWEENEY, *chairman*

Dr. Sweeney is a vice president, member of the Executive Committee and the Board, Esso Research & Engrg. Co. Born in Boston, he received his BS in chemistry from Massachusetts University, his MS in chemistry from Penn State, and DS in chemical engrg. from MIT. He was on the MIT faculty until joining Stadard Oil of La. in 1929, where he became director of the Baton Rouge research laboratories in 1934. Two years later, he moved to Esso Laboratories at Linden, N.J., and became associate director of the research division.

In additon to his company assignments, Dr. Sweeney has been widely active in the API, the Coordinating Research Council, and numerous scientific societies.

THE Automotive Research Committee is concerned with all matters involving the application of fuels and lubricants to mobile equipment. This means that the interest of the members in mobile equipment development looms almost as large as does their interest in the development of fuels and lubricants.

To enable the petroleum industry to work with the developers of mobile equipment on problems of mutual interest, the American Petroleum Institute and the Society of Automotive Engineers maintains the Coordinating Research Council, Inc. Responsibility for CRC, Inc., stems directly from the Automotive Research Committee of the Refining Division.

The CRC keeps abreast of the octane requirements of new engines, studies the lubrication requirements of new engines, and conducts studies on the effects of certain properties of fuels in the various types of engines in which those fuels are burned. Committees of the CRC study the causes of vapor lock, of car stalling, of difficult starting, and many other problems involving the design and construction of equipment as well as the composition and properties of fuels and lubricants.

In the line of direct public service, the Automotive Research Committee sees to it that the API, in cooperation with the U.S. Bureau of Mines, maintains semi-annual surveys of the quality of motor fuels marketed in the U.S.; and annual surveys of the quality of aviation fuels, diesel fuels, and heating oils.

Here you might ask, what does heating oil have to do with mobile equipment? The answer is that it does not necessarily have anything to do with mobile equipment. However, the machinery for handling surveys on the fuels for mobile equipment has long been established, and when the Refining Division's Committee on Petroleum Products moved to initiate the same sort of survey on heating oil, the most economical method was merely to add this fuel oil survey to the list of other surveys and let it be executed by the same people.

Two knotty problems will give the Automotive Research Committee a heavy meal to digest during this current year. They can best be expressed as questions:

1—What does the petroleum industry think should be done toward extending the octane number scale above 100?

2—Should there be a new basis for indicating the viscosity-temperature characteristics of lubricating oils? If so, what?

Both these questions are simpler in the asking than in the answering. It is not expected that answers will be found this year. There are several classes of people who are also interested in these questions. First, there are the engineers of the automotive industry whose opinions and desires will be a large factor in the final decisions. Secondly, the opinions and desires of those concerned with the marketing of fuels and lubricants will be heard and considered. Above both of these groups, the wishes of the purchasers of automobiles and of gasoline and oils have to be kept in mind.

Because this latter group is unorganized and, therefore, inarticulate, the engineers and researchers who have the responsibility for making the decision must be objective. Their decisions must be sound.

Committee on Analytical Research

G. R. LAKE, *chairman*

A native of Oklahoma—Hobart, 1905—Mr. Lake has a B.S. in chemical engineering (1929) and an M.A. in chemistry (1933) from the University of Texas. He was chief tutor at his alma mater from 1929 to 1933. Mr. Lake joined Union Oil Co. of California in 1933 as an analyst. He has also been a senior research chemist, and today is supervisor of the research division.

He has done considerable work in analytical chemistry and holds 15 patents, mainly in the use of azeotropic distillation from the separation of petroleum fractions. He is active in ASTM and ACS technical committees as well as the API.

THE Committee on Analytical Research, better known to those familiar with its operation as the "COAR," is composed of authorities in the analysis of petroleum and its related products. The objective is to develop and test new analytical techniques that will aid in the operation of refineries and assist in the development of new petroleum processing methods.

Ten subcommittees are responsible for the attainment of this objective. Each one carries out the necessary research for the solution of a separate phase of problems. These are the subcommittees:

Subcommittee on Trace Elements in Crude Oils and Catalytic Charge Stocks; chairman, J. T. Horeczy, Hum-

ble Oil & Refining Co., Baytown, Tex. At present, the group is interested in extending methods of analysis to a level of less than 1 ppm. Considerable attention will be paid to the purification of reagents. Elements included in the program are nickel, vanadium, iron, copper, lead, arsenic, and the halogens.

Subcommittee on Determination of Sulfur and Sulfur Types; chairman, Ralph Griffith, Sinclair Refining Co., Harvey, Ill. Principal interest is in methods for determining thiophenes, which have been shown to be the predominant type of sulfur compound in crude oil. The group is also interested in methods for total sulfur, such as the lamp method, in which elemental sulfur causes difficulties; and also the high temperature method, which is relatively new in application to petroleum products.

Subcommittee on Analytical Methods for Atmosphere; chairman, R. L. LeTourneau, California Research Corp., Richmond, Calif. Current investigation is on methods for determining small amounts of hydrocarbon in gas samples. Results thus far appear promising. The group is also taking up the problem of determining oxides of nitrogen, important because of its relation to the smog problem and because of a lack of agreement in results now being obtained by various laboratories.

Subcommittee on Determination of Physical Properties of Cracking Catalysts; chairman, L. Mittelman, Tide Water Associated Oil Co., Associated, Calif. Good progress has been made in setting screen analysis and subsieve particle size procedures as well as completing work on methods of mixing the sample. A cooperative program on skeletal density and pore volume measurements in addition to surface area measurements is being set up.

Subcommittee on Analysis of Catalysts; chairman, Ralph O. Clark, Gulf Oil Co., Pittsburgh, Penna. Investigation is continuing on methods of analysis for trace concentrations in cracking catalysts of vanadium, iron, nickel, and possibly copper and sodium. Investigation is being considered to find methods of determining platinum and arsenic in reforming catalysts.

Subcommittee on Refinery Effluent Water Analytical Methods; chairman, J. B. Rather, Jr., Socony Mobil Oil Co., Brooklyn, N.Y. A program has just been completed to establish the best methods for determining small amounts of oil in water. A low-cost infrared instrument is being evaluated for this purpose. Also being considered is the desirability of developing a satisfactory method for determining phenol in effluent waters at the level of 5 ppm.

Subcommittee on Nitrogen Type Analysis; chairman, C. W. Key, Richfield Oil Corp., Anaheim, Calif. After a successful program on methods of determining basic nitrogen in petroleum stocks at a concentration of a few hundredths of a percent, the group is extending its investigation to methods for both basic and total nitrogen at a concentration of less than 10 ppm.

Subcommittee on Analysis of Oxygenated Compounds; chairman, W. H. Jones, Esso Laboratories, Baton Rouge, La. Last phases of work are being carried out currently on methods for the determination of low concentrations of esters, carbonyl and hydroxyl groups in petroleum products.

Subcommittee on Determination of Naphthenic Hydrocarbons; chairman, S. S. Kurtz, Jr., Sun Oil Co., Marcus Hook, Penna. Work has been completed and results will be reported at the Montreal meeting of the COAR on the determination of total naphthenes in two samples of naphtha.

Subcommittee on Group Session Papers; chairman, B. J. Heinrich, Phillips Petroleum Co., Bartlesville, Okla. This group has the responsibility for selecting the papers for the group sessions on analytical research held annually at the Refining Division midyear meetings.

Information on the activities of the COAR may be obtained from the chairman; the vice chairman, B. J. Heinrich; or the secretary, R. J. Askevold, Pure Oil Co., Crystal Lake, Ill.

Committee on Disposal of Refinery Wastes

J. H. EASTHAGEN, *chairman*

Senior research engineer with California Research Corp., Mr. Easthagen came with the firm when it was organized in 1944. Born in Minnesota in 1907, he was graduated from Colorado School of Mines in 1928 with a petroleum engineering degree. He then went to work at the El Segundo, Calif., refinery of Standard Oil Co. (California) as a laboratory assistant, and was transferred to Cal Research when it was set up by Cal Standard. Mr. Easthagen went to the laboratories at Richmond in 1945 to take charge of technical services, research and development work on process effluent recovery and waste disposal.

THE current activities of the Committee on Disposal of Refinery Wastes continue to be directed toward improvement and amplification of the five volumes of a manual containing technical information on methods for handling and disposing of waste materials.

Rapid developments in pollution control require that work on a new edition of each volume be initiated as soon as the current edition is off the press.

This manual now consists of five volumes:

I—Waste Water Containing Oil—issued in 1953.

II—Waste Gases and Particulate Matter—issued in 1952.

III—Chemical Wastes—issued in 1951.

IV—Sampling and Analysis of Waste Water—issued in 1953.

V—Sampling and Analysis of Waste Gases and Particulate Matter—issued in 1954.

During the past year, work was substantially completed on a new edition of Volume II. This new edition is expected to be published late this year or early in 1957. Work is progressing rapidly on a new edition of Volume III, and publication is expected late in 1957.

At present, this committee has 10 technical subcommittees:

Subcommittee on Oil-Water Separa-

tion; chairman, H. F. Elkin, Sun Oil Co., Philadelphia, Penna.

Subcommittee on Chemical Wastes; chairman, R. J. Austin, Standard Oil Co. (Indiana), Whiting, Ind.

Subcommittee on Waste Gases and Dusts; chairman, W. H. Lang, Esso Research & Engrg. Co., Linden, N.J.

Subcommittee on Sampling and Tests; chairman, L. Mittelman, Tide Water Associated Oil Co., Associated, Calif.

Subcommittee on Fluoride Project; chairman, W. H. Barcus, Sun Oil Co., Marcus Hook, Penna.

Subcommittee on Water Quality Criteria; chairman, W. F. Meehan, Standard Oil Co. (Indiana), Whiting, Ind.

Subcommittee on Incinerator Design; chairman, A. D. McRae, Imperial Oil Co., Ltd., Sarnia, Ont.

Subcommittee on Biological Project; chairman, L. C. Burroughs, Shell Oil Co., New York, N.Y.

Subcommittee on Dust Collector Project; chairman, Randlow Smith, The Texas Co., New York, N.Y.

Subcommittee on Sludge and Spent Clay Disposal; chairman, J. A. Fowler, Sinclair Refining Co., East Chicago, Ind.

These subcommittees are currently giving attention to the following subjects:

1—Evaluation of gas flotation as a means of removing oil from waste water.

2—Investigation of economical methods for handling and disposing of oily sludge and grease.

3—Secondary treatment of waste water. This concerns treatment of waste waters following an API separation or the equivalent.

4—Development of a design for an all-purpose incinerator.

5—Treatment of various specific chemical wastes.

The results from the activities of these various subcommittees will be used in the revision and expansion of the appropriate volumes of the manual.

The committee received a report from the Academy of Natural Sciences of Philadelphia on the applicability of a bio-assay method to natural bodies of water typical of those into which refineries discharge wastes. This report will not be published at present. However, it has been released for distribution to interested parties.

Three research projects are currently being sponsored by the committee.

One project, at the Boyce-Thompson Institute, Yonkers, N.Y., is a cooperative project sponsored by a group of industries interested in determining the effects of long-time exposure of vegetation to extremely low concentrations of fluorides in the atmosphere.

A second, the initial phase of which was completed in 1955, concerns the organization of available information on dust-collecting devices. The initial phase covered the use of cyclone dust collectors for removal of particulate matter in gaseous wastes. This report will be published and available in the next few months.

The third project, which is contracted to the John Hopkins University, is a critical evaluation of currently available data on the acute and chronic toxicity for man and animals of selected chemical pollutants found in waste streams from petroleum refineries.

Committee on Smoke and Fumes

JOHN W. NEWTON, *chairman*

Mr. Newton, vice president and manager of refining for Magnolia Petroleum Co., Beaumont, Tex., was born in Dallas. After receiving a degree in chemical engineering from Texas A&M, he taught in the chemistry department from 1912 to 1914, then joined Magnolia as a chemist. He became a vice president and director of the firm in 1938. Mr. Newton has been and still is active in many industrial and civic organizations. He preceded Mr. McConnell as the API vice president for refining, and is a director of the Texas A&M Research Foundation, the Lower Neches Valley Authority, and Beaumont's American National Bank.

THE Smoke and Fumes Committee, formed in 1952 to study air pollution problems, has the general objectives of providing fundamental information on the sources and nature of objectionable air pollution. In addition to sponsoring a number of research projects in this field, active liaison is maintained with other groups working on the problem in order that the petroleum industry may be kept currently informed of all significant developments on this important subject.

During 1956 the committee continues under the chairmanship of John W. Newton (see above). W. H. Claussen, California Research Corp., San Francisco, is the executive secretary. L. C. Kemp, Jr., The Texas Co., New York, is chairman, technical advisory committee; and Vance N. Jenkins, Union Oil Co., Brea, Calif., is chairman, publications committee. In addition, there are eight project advisory committees for guidance in the fundamental research program.

Prior to this year, two research projects have been completed. One of these was carried out at the Armour Research Foundation. It revealed that the amount of unburned hydrocarbons discharged to the air in the flue gases of stationary installations such as those in domestic heating units and in plants for the generation of heat and power for industrial purposes by burning petroleum products is insignificant. In all cases the hydrocarbon content of the flue gas was under 100 ppm and in most cases it was under 30 ppm. In contrast, the hydrocarbon content of automobile exhaust has been found to be as high as 2% to 3%.

The second completed project was carried out by the University of Cincinnati and involved a survey of the atmospheres of a number of typical American cities. One object of the survey was to determine if ozone (or similar oxidant) could be found in concentrations in the high range characteristic of the air around Los Angeles during smoggy days. In all of the cities tested the ozone concentrations were much lower than those in Los Angeles. Concentrations of sulfur dioxide were, however, much higher than those in the Los Angeles air.

Four projects are being completed in 1956; one of these at Stanford Research Institute provided much technical information on the nature of the photochemical reactions occurring in

the atmosphere. It was proved that oxides of nitrogen are necessary intermediates which, under the influence of sunlight, lead to reactions with organic material to produce the irritating and damaging substances found in the Los Angeles atmosphere. The findings have provided the basis for further research.

The Industrial Hygiene Foundation of Pittsburgh studied the method of tracing emissions such as those from industrial stacks through the use of neutron activation analyses of antimony oxide dispersed into the stack. This type of tracing will make it possible to follow emissions from any given source in the atmosphere.

Another project at the Armour Research Foundation is being completed. It involves the development of a new method for analyzing the ozone in the atmosphere. By measuring the increase in temperature resulting from the catalytic decomposition of ozone, a relatively accurate and specific method of analysis was developed. The temperature increase is measured by highly sensitive thermistors.

At the University of Illinois, a project is nearing completion. Professor H. F. Johnstone and his co-workers have studied the oxidation of SO_2 to SO_3 under many conditions and have found that the oxidation is too slow, under all conditions studied, to account for the reduction in visibility observed in the atmospheres of many cities during daylight hours.

Another project at the University of Illinois, being continued, is to study the rate at which visibility may be reduced as a result of the reactions of hydrocarbons with ozone and other materials in the air.

Outstanding research work at the Franklin Institute in Philadelphia has made significant contributions to the knowledge of atmospheric photochemistry. The development of an instrument for studying the changes in the composition of polluted atmospheres by infrared techniques using path lengths up to 1440 ft has made possible the measurement of rates of some of the important reactions and the detection of intermediate products including some new and heretofore unsuspected compounds.

On the basis of the important results obtained with the instrument at the Franklin Institute, the Smoke and Fumes Committee plans to have another long-path infrared cell built for on-the-spot studies of reactions in urban atmospheres. The new equipment will be semiportable and will be first tried in Pasadena, Calif., where the concentrations of materials in the atmosphere which are of interest in this work are higher than have been found elsewhere up to this time.

A new project at the University of California will determine which kinds of compounds discovered in the air in which pollutants have undergone photochemical reactions are capable of producing the typical damage to plants that has been observed in areas where severe pollution occurs.

The committee is also co-sponsoring with the automotive industry, under the auspices of the Coordinating Research Council, a project at the Bureau of Mines, Bartlesville, Okla., which will employ the principles of gas chromatography for detailed analyses of exhaust gases.

It has been recognized for some time that positive identification of the actual reaction products in polluted air would provide valuable information on the subject. There are many serious and perhaps some virtually insurmountable problems in actually extracting and recovering the pollutants in large enough amounts for detailed chemical analyses. The project is of sufficient importance, however, to justify serious study and this study is underway.

Additional research projects are being considered for next year's program. Proposals for new research falling within the scope of the Smoke and Fumes Committee's activities will be given serious consideration. Proposals should be directed to W. H. Claussen, 200 Bush St., San Francisco 4, Calif.

Committee on Petroleum Products

R. C. ALDEN, *chairman*

Two years after graduation from Lehigh University in 1918, Mr. Alden started in the petroleum industry. Then in 1921 he became a research chemist for Chestnut and Smith Corp. Later he was a partner in Seeley-Oberfell Engrg. Corp., Breckenridge, Texas; and then superintendent of Landreth Gasoline Co.'s natural gasoline plant at Ibex, Tex. In 1925, Mr. Alden joined Phillips Petroleum Co.'s research staff as a senior chemist. In 1930 he was named assistant director, and in 1933, director of research. Today he is chairman of Phillips' research planning board. He has played an active role in the company's process pioneering projects.

THE chief function of the Committee on Petroleum Products is to be an oil industry clearing house for specifications and methods of test for petroleum products. The committee will serve in an advisory capacity to other committees of the American Petroleum Institute, and also on request, to authorized government agencies or to other organizations within its competence with particular reference to quality.

The Committee designates the API representatives to serve on Sectional Committee Z11 on Petroleum Products and Lubricants of the American Standards Association.

A recent survey made by the Committee indicates the need for periodic review of standardization activities. The subjects to receive attention at the forthcoming meeting in Montreal will be viscosity and antiknock indices.

During the past year, the work towards simplification of federal standards relating to petroleum products and lubricants has culminated in a new issue of Federal Test Method Standard No. 791, in which 78 test methods are referred to by their American Society for Testing Materials designations rather than being reprinted. This forward step will eliminate much confusion in government transactions. Further simplification will be sought.

The revised Manual on Significance of Tests for Petroleum Products and Lubricants, sponsored by Committee D-2 of ASTM, will be issued soon.

The Subcommittee on International

Standards, headed by H. W. Field, Atlantic Refining Co., Philadelphia, Penna., participated in the second meeting of the Technical Committee 28 of the International Organization for Standards in June, 1955. As a result of this meeting, the ASTM-IP Petroleum Measurement Tables and the Motor and Research Methods for Octane Number Determination are being considered as international standards. Agreement also was reached to initiate such action for several other American standards.

The Subcommittee on Viscosity Standards; chairman, J. C. Geniesse, Atlantic Refining Co., Philadelphia, Penna., continues to furnish the Alpha, Beta, and Gamma API viscosity standards, as it has done for many years. The extensive revision and expansion of the existing conversion tables for viscosity determinations has been published.

The Glossary Subcommittee; chairman, W. A. Myers, Atlantic Refining Co., Philadelphia, Penna., is reviewing the "Glossary of Terms Used in Petroleum Refining," which was first published in August, 1953.

A major activity, now in its third year, is the API Technical Abstracting Service; chairman, H. W. Field. During the past year, the coverage of the services has been amplified and a new sliding scale basis for annual subscription charges has been adopted.

Through the efforts of the Petroleum Products Committee, a useful publication, "Vapor Pressure Charts for Petroleum Hydrocarbons," has been made available through the API.

Committee on Training

J. J. STADTHERR, *chairman*

Training director of Pure Oil Co., refining division, since 1949, Mr. Stadtherr has been with the firm since 1937. Prior to his present post, he was at the Heath, Ohio, refinery, as resident chemist, assistant general operating foreman, and then training supervisor.

Mr. Stadtherr was born in 1907 at Cole Camp, Mo. He was graduated from the University of Missouri with a B.S. in chemistry and took graduate work in chemical engineering at Ohio State. From 1927 to 1937, he was analytical chemist and assistant resident chemist for Sinclair Refining Co., Coffeyville, Kans. He was appointed to his API committee chairmanship in 1955.

THE main objective of the Committee on Training is to assist management in developing capable personnel. It seeks at all levels to provide the necessary knowledge, improve skills, and maintain high employe morale by means of the best in teaching and training methods. It attempts to reach these goals through the refinery training representatives who constitute its membership.

The officers, in addition to Chairman Stadtherr, are: M. L. Mullins, Standard Oil Co. (Indiana), Chicago, Ill., vice chairman; E. R. Laminack, Socony Mobil Oil Co., New York, district committees chairman for programming; and Dean S. Turner, Standard Oil Co. (Ohio), Cleveland, district committees chairman for membership.

To provide wider distribution of the benefits of the Committee, organization of seven district committees was recently completed. Six of these came into existence during 1954 and early 1955. One, the Gulf Coast group, has been active since 1942.

The seven district committees and their respective chairmen are:

Northern California: W. M. Fothergell, Shell Oil Co., Martinez.

Southern California: W. H. Hoefle, Standard Oil Co. of California, El Segundo.

Gulf Coast: T. G. Cain, Gulf Oil Corp., Port Arthur, Texas.

Mid-Continent: James Perry, Phillips Petroleum Co., Bartlesville, Okla.

Rocky Mountain: J. R. Nolan, Sinclair Refining Co., Sinclair, Wyo.

Great Lakes: G. G. Blanchard, Jr., Gulf Refining Co., Toledo, Ohio.

Eastern: W. E. Allen, Atlantic Refining Co., Philadelphia, Penna.

Besides the district committees there are at present a number of project subcommittees:

Subcommittee on Training Literature; chairman, R. R. Faller, Ethyl Corp., New York, N.Y. This group has a continuing project of maintaining an up-to-date section on training in the library of the API. Since the committee was started in February, 1954, a sizable accumulation of training literature has been made available on a loan basis to anyone requesting it. Over 200 individuals and companies have made use of the service since its beginning. There have been over 1200 requests for the materials. (For information on available materials, see PETROLEUM PROCESSING, May, 1954, pp. 712-713, "Do You Need Training Materials? Here's an API Service to Help You Get Them," or write direct to the API.)

Subcommittee on Committee Work; chairman, T. M. Rushing, The Texas Co., New York, has completed its assignment and has been discharged. The work it completed was a publication, which will soon be available, entitled, "Navigational Notes for the New Chairman of a Division of Refining Committee." This assignment had been preceded by "The Three R's for Committeemen of the Division of Refining," published in January, 1954.

Subcommittee on Pump Manuals comprises representatives of both refiners and manufacturers. Paul F. Miller, American Oil Co., New York, is chairman of the refiners' subcommittee, and George V. Shaw, Ingersoll-Rand Co., New York, is chairman of the pump manufacturers' subcommittee. A publication, "Recommendations for the Preparation and Publication of Pump Manuals," was released by the committee in 1954. Now work is being carried on toward the publication of a general pump manual suitable for use in refinery training programs.

Subcommittee on Educational Exhibits; chairman, W. M. McMullen, Jr., Magnolia Petroleum Co., Beaumont, Tex., has the task of maintaining at the API library an up-to-date list of exhibits, cut-away models, charts, and other visual aid materials of value in refinery training programs.

Subcommittee on Case Studies; chairman, W. W. Hitchcock, Sinclair Refining Co., Houston, Tex., is well along the way to publication of a collection of about 100 incidents for use

in supervisory training by the case study method. The publication will include instructions on the use of the method and a bibliography on the subject.

A number of agencies and foundations have been doing good work in the broad area of adult education. A subcommittee under the chairmanship of Leroy Wilkie, Humble Oil & Refining Co., Baytown, Tex., is devoting its attention to this subject. It is reporting to the main committee on adult education programs which have possible refinery training application.

A Subcommittee on New Projects; chairman, E. W. Freeman, Cities Service Oil Co., New York, is actively engaged in attempts to peer into the future. It is seeking to project the type and scope of training activities which the future will require. On the basis of its findings, it then recommends projects which it believes to be appropriate tasks for the API training committee.

A Subcommittee on Manpower; chairman, R. E. Goff, Shell Oil Co., New York, was named in October, 1955. Its job is to review the list of critical occupations for the refining industry and to make appropriate changes. This work was done at the request of the Technical Manpower Subcommittee of the National Petroleum Council, completed and reported at the San Francisco API meeting last November, 1955.

The Training Committee has a full schedule of meetings set for Montreal, and has arranged a program of speakers for a session on Thursday morning, May 17.

Committee on Refinery Equipment

RUSSELL H. VENN, *chairman*

Mr. Venn, manager of refining, Humble Oil & Refining Co., was born in Michigan in 1912. He was graduated from Wayne University with a B.S. in chemical engineering in 1933, and received an M.S. in chemical engineering at M.I.T. the following year. Mr. Venn then joined Humble as a junior chemical engineer at the Baytown refinery. In 1938 he became section head in the technical service division, and in 1942 a senior project engineer. He was named technical assistant to the director in charge of refining at Houston in 1945.

On January 1, 1955, Mr. Venn was promoted to his present position with Humble.

THIS committee serves the industry in the design, construction, inspection, and maintenance of equipment. It fosters the API program of refinery equipment standardization where standards do not exist or are inadequate. Through its representatives in other organizations it attempts to insure that standards developed by those organizations are acceptable to the refiner. It formulates recommended practices for industry-wide use to promote safety and efficient operations. Much of this work is carried out by 10 subcommittees.

The Subcommittee on Electrical Equipment, L. M. Goldsmith, Atlantic Refining Co., chairman, continued work on a manual of recommended practices for electrical installations. It is also considering possible improvements to RP-500, "Classification of Areas for Electrical Installations in Petroleum Refineries," and will sponsor a session on this subject at the Montreal meeting.

The Subcommittee on Piping and Valves, J. P. Mooney, Humble Oil & Refining Co., chairman, is working closely with API representatives in other organizations that are developing piping standards, material specifications, and codes. With the assistance of a manufacturer's subcommittee, W. P. Kliment, Crane Co., chairman, it will also consider any necessary revisions and additions to API-600, "Specification for Flanged and Welding End Steel Gate and Plug Valves for Refinery Use."

The Subcommittee on Instruments, G. N. Ehly, Atlantic Refining Co., chairman, continued preparation of a manual of recommended practices for instrument installation. It is sponsoring a session on Trends in Refinery Instrumentation at Montreal.

The Subcommittee of Refinery Inspection Supervisors, W. K. Brown, Standard Oil Co. (Indiana), chairman, continues work on the "Guide for Inspection of Refinery Equipment." It is being assisted by a Designers' Subcommittee, J. H. Rickerman, M. W. Kellogg Co., chairman.

The Subcommittee on Corrosion, H. G. Mangelsdorf, Esso Standard Oil Co., chairman, is studying several important corrosion problems. It will follow a research project on high temperature H_2S corrosion at a large university. It also is sponsoring a session on Corrosion at Montreal.

The Subcommittee on Tubing, L. G. Molique, Phillips Petroleum Co., chairman, is working on exchanger tube and fired-heater tube standardization, and is developing a recommended practice for the calculation of heater tube thicknesses.

The Subcommittee on Unfired Pressure Vessels, N. J. Rees, Socony Mobil Oil Co., chairman, continued studies of fabrication methods and materials for pressure vessels in refining service. It is interested particularly in improvement of welding quality, design of alloy-clad vessels, and fabrication of low chrome-moly alloy vessels.

The Subcommittee on Mechanical Equipment, E. F. Voss, Humble Oil & Refining Co., chairman, is working on specifications for centrifugal compressors and mechanical-drive steam turbines. It is being assisted by two manufacturers' subcommittees: T. P. Latimer, Clark Bros. Co., and R. C. Twombly, Westinghouse Electric Corp., chairmen.

The Subcommittee on Pressure-Relieving Systems has completed its "Recommended Practices for the Design and Construction of Pressure-Relieving Systems in Refineries." J. C. Souder, Esso Research & Engrg. Co., chairman for the past several years, relinquished his post early this year to E. D. Underwood, Shell Oil Co.

The Subcommittee on Low-Pressure Welded Storage Tanks, W. L. Bowler, Pure Oil Co., chairman, has completed its "Recommended Rules for the Design and Construction of Large, Low-Pressure Welded Storage Tanks," and the publication is now available to the industry.

New Process Design Methods for

Optimum Bubble-Cap Tray Design

PART IV—DESIGN EXAMPLE

By WILLIAM L. BOLLES

Manager of Process Design, Monsanto Chemical Co., Texas City, Texas

PART I of this series recommended methods for making tray dynamic calculations. Part II established design standards for all components of tray design. Part III outlined design techniques by which optimum tray design can be achieved. Part IV, now, will demonstrate the application of the material given in the first three parts by the solution of a typical problem.

The example case chosen is the top plate of a benzene-toluene fractionator. The choice of this case as an example is purely arbitrary. The choice is relatively unimportant, since the principles and techniques used are identical whether the application be in crude oil topping, gasoline stabilization, ethylene absorption at high pressure, or styrene fractionation under vacuum.

The example to follow will include an analysis of only the top plate. The same procedure should be used on the bottom plate, as well as any other critical plates as recommended in Part III.

The example calculations will be rather complete and detailed in the interest of clarity. The experienced designer, however, will learn to take many short-cuts and arrive at the same end result with but a fraction of the work indicated here.

The example will begin with the process requirements of the example case. The tower size will be estimated by an old[2,5,6] approximate method. Then the tower size will be re-estimated by the new method.

The first tray layout will be of very conservative size. Then the layout will be developed and improved in order to permit smaller and smaller column diameters. The alternate tray designs will be compared and evaluated on the basis of a cost analysis. Then, the optimum tray design will be selected on the basis of minimum cost.

Finally, a tray performance chart will be developed to demonstrate the operating characteristics of the recommended tray.

Process Requirements

The example case chosen is the top tray of a benzene-toluene fractionator, where the material handled is essentially benzene. This fractionator is to operate at 14.7 psia with an external reflux ratio (L/D) of 5:1.

A complete resume of the process requirements is given in Table 12. In this table are given the maximum anticipated liquid and vapor loads. It will also be noted that the requirements include the stipulation that the trays must be operable at 50% of the maximum loads.

Table 12—Process requirements for example case

Top plate in benzene-toluene fractionator

Material	Essentially benzene
Molecular weight	78.1
Operating pressure, psia	14.7
Operating temperature, °F	176
Liquid density, lb./cu. ft.	43.3
Vapor density, lb./cu. ft.	0.168
Liquid surface tension, dynes/cm.	21
Maximum liquid load	200,000 lb./hr. or 577 gpm
Maximum vapor load	240,000 lb./hr. or 397 cfs
Reflux ratio, L/V	0.833
Assumed local dry plate efficiency at max. loading, %	70
Total required theoretical plates in fractionator	40
Minimum anticipated loads, % of max. loads	50

Estimated Size by Old Method

The required column diameter will now be estimated by the old method.[2] The nomenclature employed in these calculations corresponds to that in the previous reference. The tray spacing is taken at 24 in.

First, the column diameter is estimated on the basis of the vapor load limiting. Based on the liquid surface tension being greater than 20 dynes/cm., the Souders and Brown constant is found to be 640 ft./hr. The maximum allowable superficial vapor velocity is then obtained as follows:

$$u_{max.} = \frac{C}{3600}\sqrt{\frac{\rho_L - \rho_V}{\rho_V}}$$

$$= \frac{640}{3600}\sqrt{\frac{43.3 - 0.168}{0.168}} = 2.85 \text{ ft./sec.}$$

Introducing the recommended safety factor of 25%, the design superficial vapor velocity becomes:

$$\frac{2.85}{1.25} = 2.28 \text{ ft./sec.}$$

The required tower diameter is then obtained:

$$\frac{397 \text{ cu. ft./sec.}}{2.28 \text{ ft./sec.}} = 174 \text{ sq. ft.}$$

$$D = \sqrt{\frac{4 \times 174}{\pi}} = 14.9 \text{ ft.}$$

Next, a check is made on the liquid capacity of the 14.9-ft. trays on 24-in. tray spacing, using the standard double-pass tray design. The liquid load is converted to the required units:

$$577 \text{ gpm} \times 60 = 34{,}500 \text{ gph}$$

$$\frac{577 \text{ gpm}}{7.48 \times 60} = 1.28 \text{ cu. ft./sec.}$$

[6]All references are listed in Part I, February, 1956, pg. 80.

The factor P is then determined:

$$P = \left(\frac{240{,}000}{200{,}000}\right)^2\left(\frac{43.3}{0.168}\right) = 372$$

The remainder of the calculations then proceed as follows:

h_{ow}/F	0.78
F	1.00
h_{ow}	0.78 in.
h_d	0.034 in.
h_{cc}/P	0.0053
P	372.
h_{cc}	1.97 in.
h_w	2.50 in.
h_{ow}	0.78 in.
$h_w + h_{ow}$	3.28 in.
$2(h_w + h_{ow})$	6.56 in.
h_d	0.03 in.
h_{cc}	1.97 in.
$H = h_d + h_{cc} + 2(h_w + h_{ow})$	8.56 in.
$S_{min} = 2H$	17.1 in.

Thus the estimated minimum tray spacing is 17.1 in., as compared to the installed tray spacing of 24 in., and it is concluded that the 14.9-ft. tray has adequate liquid capacity.

Therefore, the estimated tower diameter by the old method is 14.9 feet.*

Estimated Size by New Method

Now the column diameter will be re-estimated by the new method given in Part III. From here on, the nomenclature will correspond to that given in Part I.

1—Make tentative selection of bubble-cap. The standard 4-in. carbon steel bubble-cap is selected. From Table 4, Part II, the following data on this cap is noted:

Slot shape	Trapezoidal, $R_s = 0.50$
Slot height	1.25 in.
Slot area	8.12 sq. in.
Cap area	13.15 sq. in.

2—Calculate minimum slot area. The required minimum slot area for fully-loaded slots is determined from Fig. 3, Part I, as follows:

$$V_m = C_s\sqrt{H_s\left(\frac{\rho_L - \rho_v}{\rho_v}\right)}A_s$$

$$397 = 0.74\sqrt{1.25\left(\frac{43.3 - 0.168}{0.168}\right)}A_s$$

$$= 13.30A_s$$

$$A_s = \frac{397}{13.30} = 29.9 \text{ sq. ft.}$$

3—Select cap spacing. The cap spacing is selected as 25% of the cap diameter, which seems reasonable based on past experience with similar conditions.

4—Determine required allocated cap area. From Table 11, Part III, it is observed that with 4-in. standard caps on 25% spacing, the ratio of slot to allocated cap area is 0.36. The required allocated cap area then is obtained:

$$\text{Required allocated cap area} = \frac{29.9}{0.36} = 83 \text{ sq. ft.}$$

5—Estimate tower size. Assuming that the allocated cap area is approximately 60% of the total tower area, the tower size is estimated as follows:

$$A_t = \frac{83}{0.60} = 138 \text{ sq. ft.}$$

$$D_t = \sqrt{\frac{4 \times 138}{\pi}} = 13.3 \text{ ft.}$$

6—Select tray type. Based on the estimated tower diameter of 13.3 ft., and the liquid load of 577 gpm, Table 9, Part III, indicates a double-pass tray would be most suitable.

7—Reconsider cap selection. It is noted that Table 6, Part II, recommends 4-in. bubble-caps for columns 4 to 15 ft. in diameter. Therefore, the 4-in. cap is regarded as satisfactory.

8—Estimate distribution of tray areas. Part III recommends a side-downcomer weir length from 50 to 60% of the tower diameter, and a center weir width of 8 to 12 in. Assuming a side-downcomer weir length of 50%, and a center-downcomer width of 10 in., the downcomer area per tray is estimated as follows:

Side downcomer area (Fig. 31)		
Each		$3\%\ A_t$
Total per tray		$6\%\ A_t$
Center downcomer area		
Width	10 in. or 0.83 ft.	
Length	13.3 ft.	
Area, (13.3×0.83)	11 sq. ft.	
$(11/138)100$		$8\%\ A_t$
Total downcomer area (to and from), $(6 + 8)$		$14\%\ A_t$

Then from Table 10, Part III, the distribution of tray areas is estimated as follows:

Downflow (to and from)	14%
Liquid distribution	9%
End Wastage	7%
Allocated cap (by difference)	70%
Total tower area	100%

9—Re-estimate tower size. The tower size is then re-estimated as follows:

$$A_t = \frac{83}{0.70} = 118 \text{ sq. ft.}$$

$$D_t = \sqrt{\frac{4 \times 118}{\pi}} = 12.3 \text{ ft.}$$

Thus it appears likely that the process requirements can be met by a properly-designed tray of 12-ft. diameter.

10—Select tray spacing. Based on the recommendation of Table 6, Part II, a tray spacing of 24 in. is selected.

Tray Layout No. 1

Ordinarily, the first tray layout would be attempted in a tower of the size just estimated, namely 12 ft. The tray type, cap size, and cap spacing would also be selected in accordance with the above estimate.

However, in order to illustrate how the new design procedures can be employed to determine optimum tray design, the first tray layout will be purposely made larger than necessary. Furthermore, poor choices of tray type, cap size, and cap spacing will be made in the first layout

*Incidentally, there is a typographical error in the previous article[2] in that Figs. 6 and 7 are reversed. Fig. 6 applies to the *medium*-riser tray, while Fig. 7 applies to the *low*-riser tray.

Table 13—Basis of design for Tray Layout No. 1

Tower diameter (ID), ft.	15
Tray spacing, in.	24
Tray type	cross-flow
Weir length, % of tower diameter	70
Bubble-cap size, in.	6
Bubble-cap spacing, % of cap diameter	37.5
Bubble-cap pitch	equilateral triangle
Skirt clearance, in.	0.50
Static seal, in.	1.00
Cap stepping	none

Table 14—Bubble-cap design, Tray Layout No. 1

Material	carbon steel
Nominal size, in.	6
Cap	
Wall thickness, U.S. Standard gage	12
Outside diameter, in.	6.093
Inside diameter, in.	5.875
Height overall, in.	3.750
Number of slots	39
Type of slots	trapezoidal
Slot width	
Bottom, in.	0.333
Top, in.	0.167
Slot height, in.	1.500
Height shroud ring, in.	0.250
Riser	
Wall thickness, U.S. Standard gage	12
Outside diameter, in.	4.093
Inside diameter, in.	3.875
Height, in.	2.750
Riser-slot seal, in.	0.500
Hold-down bolt diameter, in.	0.375
Cap areas	
Riser, sq. in.	11.68
Reversal, sq. in.	17.40
Annular, sq. in.	13.95
Slot, sq. in.	14.64
Cap, sq. in.	29.0
Area ratios	
Reversal/riser	1.49
Annular/riser	1.20
Slot/riser	1.25
Slot/cap	0.50

in order to further aid the demonstration of how to improve tray design.

The basis of design for Tray Layout No. 1 is given in Table 13. The bubble-cap selected for this tray is the standard 6-in. carbon steel cap. Complete data on this cap, taken from Table 4, Part II, is reproduced in Table 14.

The weirs and downcomers are calculated as follows:

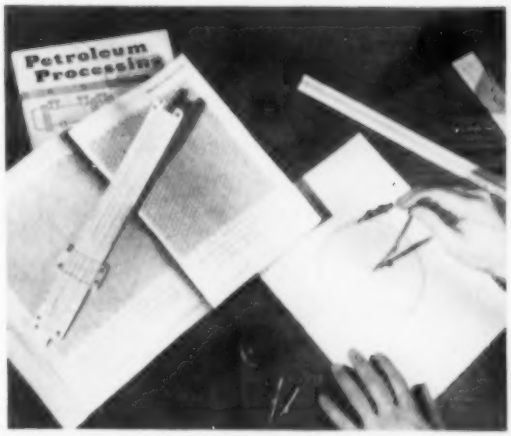
Tower diameter	15 ft. or 180 in.
Tower area	176.7 sq. ft.
Weir length, (180×0.70)	126 in.
Downcomer width (Fig. 31)	$14.2\%\ D_t$
(180×0.142)	25.5 in.
Downcomer area, one side (Fig. 31)	$8.8\%\ A_t$
(176.7×0.088)	15.6 sq. ft.

Taking a sheet of tracing paper, and using an engineer's scale of 1/30, a circle is drawn 6 in. in diameter to represent the 180-in. tower. Next, two lines are drawn in to indicate the location of the weirs 25.5 in. from the tower wall on each side of the tray.

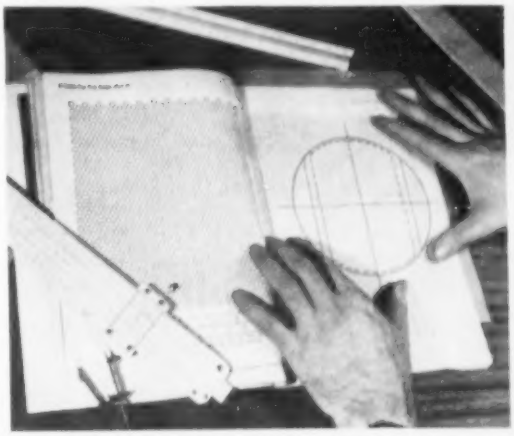
Consulting Table 6, Part II, it is noted that the recommended minimum clearance from caps to weir (and downflow baffle) is 3 in., and from caps to tower wall is 1.5 in. Dotted lines are then drawn parallel to the weirs 3 in. in toward the center, and a dotted circle is drawn 1.5 in. in from the tower wall, both according to scale, as shown in Fig. 38.

The tracing paper so marked is then superimposed on Fig. 36, Part III, which is the layout chart for 37.5%

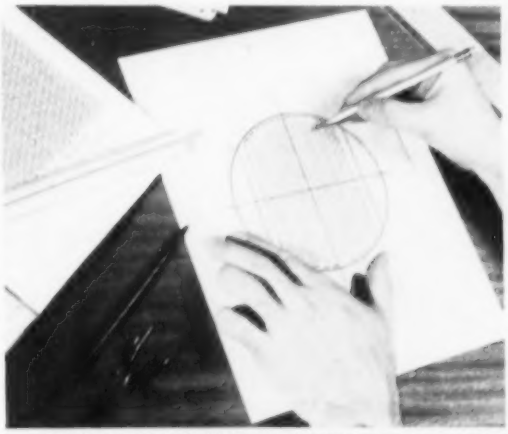
Fig. 38—**HOW TO USE THE BUBBLE-CAP LAYOUT CHARTS**



1—TAKE A SHEET OF TRACING PAPER and draw a circle to scale to represent the inside tower diameter. Also sketch in downcomers and minimum bubble-cap clearances to weirs, downcomers, and tower wall



2—SUPERIMPOSE THE MARKED-UP TRACING on the appropriate bubble-cap layout chart (Figs. 34-37, Part III, April, 1956, pp 76-79) and orient for maximum number of caps within the allocated cap area. Trace in bubble-caps on tracing paper



3—COUNT THE NUMBER OF BUBBLE-CAPS provided on the tray within the allocated tray area

bubble-cap spacing. The tracing paper is oriented so that the liquid flow is horizontal, and shifted from left to right, and up and down until the maximum number of bubble-caps are obtained within the dotted area where caps are permitted.

When the optimum orientation is obtained, it will be observed there are 17 rows of bubble-caps. When the rows are centered, the distance between the last row of caps and the overflow weir and downflow baffle is measured as about 4.3 in., which is greater than the minimum allowable clearance.

The total number of bubble-caps on the tray are counted to be 325. The resulting tray layout is shown in Fig. 39. Only one-quarter of the tray is shown in the interest of clarity. Note the location of the redistribution baffles.

The weir setting is obtained as follows:

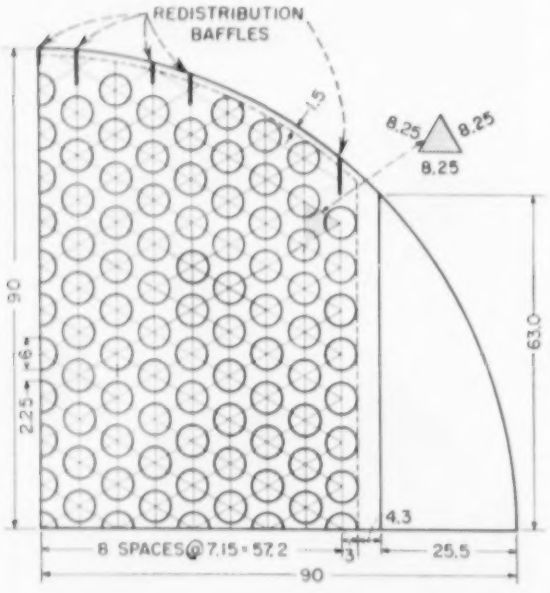
Skirt clearance	0.50 in.
Shroud ring	0.25 in.
Slot height	1.50 in.
Static seal	1.00 in.
Weir setting	3.25 in.

Noting that the distance from weir to downcomer baffle is 10.8 ft., Table 6, Part II, recommends that the downflow baffle seal be 1.5 in. The area under the downflow baffle is then obtained:

Clearance under baffle (3.25 − 1.50)	1.75 in.
Area under baffle (1.75 × 126)/144	1.5 sq. ft.

The critical tray areas may then be summarized as follows:

	Per cap, sq. in.	Per tray, sq. ft.	% of tower area
Riser area	11.68	26.4	14.9
Slot area	14.64	33.1	18.7
Downflow area, one side	——	15.6	8.8
Area under baffle	——	1.5	0.8
Tower area	——	176.7	100.0



All dimensions in inches

Fig. 39—**TRAY LAYOUT NO. 1**—to fit 15 ft. ID column

Tray Dynamics — Tray Layout No. 1

Mean slot opening—The mean slot opening is computed from Fig. 3, Part I, as follows:

$$R_s = \frac{0.167}{0.333} = 0.50$$

$$V_m = C_v\sqrt{H_c\left(\frac{\rho_L - \rho_V}{\rho_V}\right)}\,1.$$

$$= 0.74\sqrt{1.50\left(\frac{43.3 - 0.168}{0.168}\right)}\,(33.1) = 480 \text{ cfs}$$

Actual vapor load, (397/480)100	82.7%
Mean slot opening (Fig. 3)	90% slot height
(1.50 × 0.90)	1.35 in.

Liquid height over weir—The height of liquid over the weir is computed with Equation 29 and Fig. 4, Part I:

$$\frac{Q}{(L_w)^{2.5}} = \frac{577}{(10.5)^{2.5}} = 1.6$$

From Fig. 4, $F_w = 1.02$

$$h_{ow} = 0.092F_w\left(\frac{Q}{L_w}\right)^{2/3}$$

$$= 0.092 \times 1.02\left(\frac{577}{10.5}\right)^{2/3} = 1.35 \text{ in.}$$

Bubble cap pressure drop—The partial pressure drop through risers, reversals and annuli is obtained with Equation 59 in which the coefficient is obtained from Fig. 15, Part I. The total cap drop is obtained by Equation 61, as follows:

Annular/riser area	1.20
K_c	0.53

$$h_{pc} = K_c\left(\frac{\rho_V}{\rho_L - \rho_V}\right)\left(\frac{V}{A_r}\right)^2$$

$$= 0.53\left(\frac{0.168}{43.3 - 0.168}\right)\left(\frac{397}{26.4}\right)^2 = 0.47 \text{ in. liq.}$$

$$h_c = h_{pc} + h_s = 0.47 + 1.35 = 1.82 \text{ in. liq.}$$

Liquid gradient—The uncorrected liquid gradient per row of caps is determined from Fig. 10, Part I. This is multiplied by the number of rows, and corrected for vapor load by means of Fig. 12, as follows:

Mean flow width		13.4	ft.
Liquid flow density, (577/13.4)		43	gpm/ft.
Skirt clearance		0.50	in.
Mean liquid depth	assume	5	in.
Uncorrected liquid gradient:			
Per row (Fig. 10)		0.103	in.
Total, (17 × 0.103)		1.75	in.
Superficial vapor velocity, (397/177)		2.24	ft./sec.
$u_s\sqrt{\rho_V}$, $(2.24\sqrt{0.168})$		0.92	
Vapor load corr. factor (Fig. 12)	C_v =	0.93	
Corrected liquid gradient, (1.75 × 0.93)		1.63 in.	

Check on mean liquid depth:

$$h_l = h_w + h_{ow} + \Delta/2$$
$$= 3.25 + 1.35 + 1.63/2 = 5.4 \text{ in. (close enough)}$$

Vapor distribution ratio—The vapor distribution ratio is determined by Equation 69, Part II:

Liquid gradient ..... 1.63 in.
Cap pressure drop ..... 1.82 in. liq.

$$R_V = \frac{\Delta}{h_c} = \frac{1.63}{1.82} = 0.90$$

Mean dynamic slot submergence—The mean dynamic slot submergence is obtained from Equation 67, Part II, as follows:

$$h_{ds} = h_w + h_{ow} + \Delta/2$$
$$= 1.00 + 1.35 + 1.63/2 = 3.16 \text{ in.}$$

Tray pressure drop—The tray pressure drop is obtained by application of Equation 62, Part I:

$$h_t = h_c + h_{ds} + h_{ow} + \Delta/2$$
$$= 1.82 + 1.00 + 1.35 + 1.63/2 = 4.98 \text{ in. liq.}$$

Liquid height in downcomer—The head loss under the downflow baffle is computed by Equation 63, Part I, and the depth of clear liquid in the downcomer by Equation 64:

$$h_d = 0.03\left(\frac{Q}{100A_d}\right)^2$$
$$= 0.03\left(\frac{577}{100 \times 1.5}\right)^2 = 0.44 \text{ in. liq.}$$
$$H_d = h_w + h_{ow} + \Delta + h_d + h_t$$
$$= 3.25 + 1.35 + 1.63 + 0.44 + 4.98 = 11.65 \text{ in.}$$

Available downflow height, 24 + 3.25 ..... 27.25
Height clear liquid, (11.65/27.25)100 ..... 43%

Downflow residence time—The downflow residence time is computed as follows:

Downflow area ..... 15.6 sq. ft.
Tray spacing ..... 2.0 ft.
Downflow volume, (15.6 × 2.0) ..... 31.2 cu. ft.
Liquid flow rate ..... 1.29 cfs
Downflow residence time, (31.2/1.29) ..... 24 sec.

Liquid throw over weir—Equation 40, Part I, is used to determine the distance of free fall, and this is applied in Equation 39 to estimate the liquid throw as follows:

$$h_f = T + h_w - H_d$$
$$= 24 + 3.25 - 11.65 = 15.6 \text{ in.}$$
$$t_w = 0.8\sqrt{(h_{ow})(h_f)}$$
$$= 0.8\sqrt{1.35 \times 15.6} = 3.7 \text{ in.}$$

Downflow width ..... 25.5 in.
Liquid throw, (3.7/25.5)100 ..... 14%

Entrainment—The entrainment is obtained by use of Fig. 18, Part I, as follows:

Tower area ..... 176.7 sq. ft.
Downcomer area (one side) ..... 15.6 sq. ft.
Available flow area (A_f), (177 − 2 × 15.6) ..... 146 sq. ft.
Vapor velocity (u_f), (397/146) ..... 2.72 ft./sec.
Abscissa in Fig. 18:

$$x = \frac{27.3}{T} + 10.75u_f\sqrt{\frac{\rho_V}{\rho_L - \rho_V}}$$
$$= \frac{27.3}{24} + 10.75 \times 2.72\sqrt{\frac{0.168}{43.3 - 0.168}} = 2.97$$

Interfacial tension ..... 21 dynes/cm.
Ordinate in Fig. 18 (extrapolated):

$$y = 0.20 = \frac{G_e}{h_{ow} + h_{ds} + h_s}$$

Entrainment:

$$G_e = 0.20(h_{ow} + h_{ds} + h_s)$$
$$= 0.20(1.35 + 1.00 + 1.35) = 0.74 \text{ lb./min.-sq. ft.}$$
$$0.74 \times 146 = 108 \text{ lb./min.}$$

Vapor load, (240,000/60) ..... 4,000 lb./min.
Entrainment ratio, (108/4,000) ..... 0.027 mol/mol dry vapor
Entrainment quotient (Equation 78):

$$R_e = \frac{eE_d}{R} = \frac{0.027 \times 0.70}{0.833} = 0.023$$

Plate efficiency—The local dry vapor efficiency given in Table 12 is corrected for entrainment by Equation 65, Part I. This is followed by correction for liquid concentration gradient by Equation 66, wherein the number of stages is estimated from Fig. 20:

Local dry plate efficiency 0.70
Local wet plate efficiency:

$$E_w = \frac{E_d}{1 + \frac{eE_d}{R}} = \frac{0.70}{1 + \frac{0.027 \times 0.70}{0.833}} = 0.68$$

Length of liquid path (17 rows) ..... 9.5 ft.
Number of stages for moderate mixing (Fig. 20) 7
Overall plate efficiency:

$$E_o = R\left[\left(1 + \frac{E_w}{nR}\right)^n - 1\right]$$
$$= 0.833\left[\left(1 + \frac{0.68}{7 \times 0.833}\right)^7 - 1\right] = 0.98$$

Summary—Tray Layout No. 1

The tray dynamic results for Tray Layout No. 1 are summarized in Table 15, along with a comparison against the tray dynamic standards from Table 6, Part II. It will be noted here that all tray dynamic factors for this tray are within the standard range except for mean dynamic slot seal and vapor distribution ratio.

Table 15—Summary of tray dynamics for Tray Layout No. 1

At maximum anticipated loads

	Tray No. 1	Standard
Mean slot opening, % slot height	90	100 max.
Mean dynamic slot seal, in.	3.2*	1.0-2.0
Vapor distribution ratio, Δ/h_c	0.90*	0.5 max.
Height clear liquid in downcomer, % of downflow height	43	50 max.
Downflow residence time, sec.	24	5 min.
Liquid throw over weir, % downflow width	14	60 max.
Entrainment, mol/mol dry vapor	0.027	0.10 max.
Entrainment quotient, eE_d/R	0.023	0.10 max.
Tray pressure drop, in. liq.	5.0	——
Overall plate efficiency, %	98	——

*Factors outside standard range

It will be noted that the slot area provided is more than necessary. Similarly, the static seal is considerably greater than required. Obviously, the liquid gradient is far too great. However, the amount of entrainment is quite negligible.

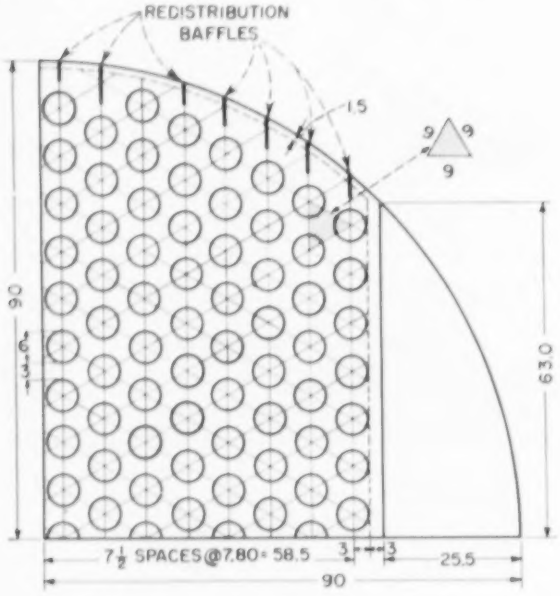
Based on the above analysis, a decision was made to stick with the same tower diameter, but modify the tray components in an attempt to bring all tray dynamic factors within the standard ranges. This will be done by

(1) widening the cap spacing, (2) raising the skirt clearance, and (3) reducing the static seal.

Tray Layout No. 2

In this tray layout the objective is to improve the previous layout so as to achieve in the 15-ft. column a tray which will meet all the dynamic standards. To this end, the cap spacing was increased from 37 to 50% of cap diameter, the skirt clearance was increased from 0.5 to 1.0 in., and the static seal was decreased from 1.0 to 0.5 in. The complete design basis for the new tray is summarized in Table 16.

Following the changes in design basis, the second tray was laid out in the same manner as the first. In this case, it was found that only 272 bubble-caps could be accommodated on the tray. A drawing of the new layout is given in Fig. 40.



All dimensions in inches

Fig. 40—**TRAY LAYOUT NO. 2**—to fit 15 ft. ID column

Based on this layout, complete tray dynamic calculations were conducted following the same procedure as that used on Tray No. 1.

The results of the tray dynamic calculations are presented in Table 16. Here it will be noted that there is considerable improvement in the vapor distribution ratio, which is now well within the standard range. The only factor remaining off standard is dynamic slot seal. This value, however, is only slightly outside the standard range, which is of little consequence. Decreasing the static seal further would not be recommended because of the danger of sacrificing plate efficiency at low loads.

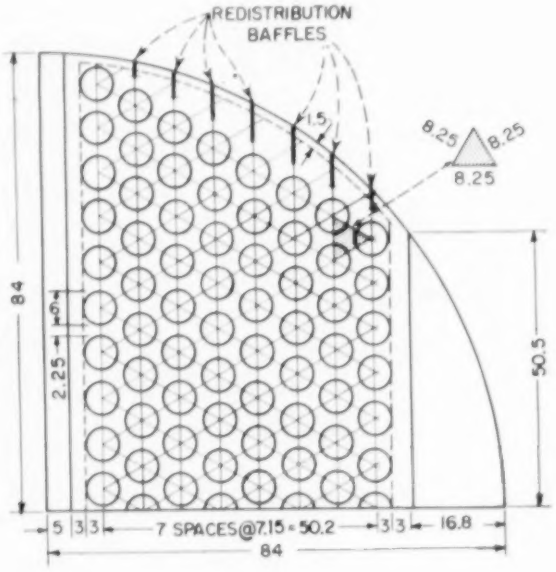
It is apparent that we are now down to the minimum number of 6-in. bubble-caps, since the calculated slot opening is 99% of the slot height. Some of the tray dynamic factors indicate that a smaller tower is possible. However, with the number of bubble-caps and the cap spacing fixed, it is doubtful that a smaller tower could accommodate the required caps in a cross-flow tray.

Therefore, a decision was made to explore the possibilities of a double-pass tray.

Tray Layout No. 3

In the third tray layout, an attempt was made to meet the process requirements within a 14-ft. column by means of employing a double-pass tray. The standard 6-in. caps were retained, but they were spaced at only 37% in order to crowd in the required number of bubble-caps. The skirt clearance was dropped back to 0.5 in. and the static seal increased to 1.0 in. The side weirs were set at 60% of tower diameter in order to suit the characteristics of a double-pass tray. The complete basis for this tray layout is given in Table 16.

Following this basis for the design, the tray layout shown in Fig. 41 was developed. It was found that only 264 caps could be worked into the 14-ft. layout.



All dimensions in inches

Fig. 41—**TRAY LAYOUT NO. 3**—to fit 14 ft. ID column

In double-pass trays, the tray dynamics differ from side-downcomer to center-downcomer trays, and so it was necessary to compute the tray dynamics on both types.

The tray dynamic results are shown in Table 16. It will be noted that only two tray dynamic factors are outside the standard range. The slot capacity is exceeded, but the 2% overload is regarded as insignificant. The dynamic slot seal is also a little outside the standard range, but this is of little consequence. Therefore, Tray Layout No. 3 is regarded as satisfactory to provide the required performance. Note the reduction in plate efficiency because of the decreased liquid path in the double-pass tray.

Further examination of the tray dynamic results on Tray No. 3 indicates that even further reduction in tower size should be possible. Because of the low vapor distribution ratio, the bubble-caps could be placed closer together. Furthermore, the high down-flow residence time and low liquid throw over the weir indicate that the side downcomers are larger than necessary.

Up to this point, it will be noted that the estimated amount of entrainment is very low indeed, and that the limit of superficial vapor velocity is still far from reached.

Table 16—Summary and comparison of tray designs

Tray design No.	Standard	1	2	3	4	5	6						
Tray design basis													
Tower I.D., ft.		15.0	15.0	14.0	13.5	13.0	12.0						
Tower area, sq. ft.		176.7	176.7	153.9	143.1	132.7	113.1						
Tray spacing, in.		24	24	24	24	24	24						
Tray type		cross-flow	cross-flow	double-pass	double-pass	double-pass	double-pass, stepped caps						
Side weir length, % TD		70	70	60	50	50	50						
Nominal cap size, in.		6	6	6	6	4	4						
Cap spacing/cap diam.		0.37	0.50	0.37	0.31	0.31	0.25						
No. caps per tray		325	272	264	264	576	560						
Cap skirt clearance (outlet row), in.		0.5	1.0	0.5	0.5	0.5	1.0						
Static seal (outlet row), in.		1.0	0.5	1.0	1.0	1.0	0.5						
Cap stepping, in.		0.0	0.0	0.0	0.0	0.0	0.5						
Tray dynamics													
Loading conditions		maximum	maximum	maximum		maximum		maximum		maximum		minimum	
Tray				side DC	cen. DC	side DC	cen. DC	side DC	cen. DC	side DC	cen. DC	side DC	cen. DC
Mean slot opening, % slot height**	100 max.	90	99	102*	102*	102*	102*	95	95	97	97	66	66
Inches	0.5 min.	1.35	1.49	>1.50	>1.50	>1.50	>1.50	1.19	1.19	1.21	1.21	0.83	0.83
Mean dynamic slot seal, in.	1.0-2.0	3.2*	2.2*	2.2*	2.1*	2.5*	2.4*	2.7*	2.6*	2.2*	1.6	1.3	1.0
Max. vapor dist. ratio, Δ/h_c	0.5 max.	0.90*	0.34	0.19	0.19	0.26	0.26	0.50	0.50	0.36	0.36	0.47	0.47
Ht. clear liq. in DC, % DF ht.	50 max.	43	38	33	31	36	34	38	36	40	32	25	22
Downflow residence time, sec.	5 min.	24	24	25	18	12	17	11	16	10	14	20	28
Liq. throw over weir, % DF wd.	60 max.	14	15	20	58	33	56	34	55	37	60	33	55
Entrainment, mol/mol dry vapor	0.10 max.	0.027	0.025	0.044	0.042	0.050	0.048	0.061	0.058	0.100	0.082	0.003	0.003
Entrainment quotient, eE_d/R	0.10 max.	0.023	0.021	0.037	0.035	0.042	0.040	0.051	0.048	0.084	0.069	0.003	0.003
Tray pressure drop, in. liq.		5.0	4.4	4.4	4.1	4.7	4.4	4.8	4.5	4.3	3.7	2.4	2.1
Over-all plate efficiency, %		98	98	90	90	89	89	89	89	85	87	....	....
Tower cost (30 theoretical trays)													
No. trays required		41	41	44		45		45		46			
Over-all tower height, ft.		92	92	98		100		100		102			
Cost of trays, installed:													
Per sq. ft. tower area, $		10.90	10.60	11.80		11.80		13.30		13.30			
Each tray, $		1,920	1,870	1,810		1,700		1,780		1,500			
Total for tower, $		79,000	77,000	79,000		77,000		80,000		69,000			
Cost of column, fabricated, $		36,000	36,000	34,000		32,000		30,000		27,000			
Total tower cost, unerected, $		115,000	113,000	113,000		109,000		110,000		96,000			

*Factors outside standard range **Expressed as % slot capacity when over 100

Tray Layout No. 4

In this layout an attempt was made to crowd the required number of 6-in. caps into a 13.5-ft. column by means of decreasing the cap spacing from 37 to 31%, and the side weirs from 60 to 50%. All other design premises are the same as in Tray No. 3, as shown in Table 16.

By these measures it was found possible to retain the 264 6-in. caps, as shown in the layout, Fig. 42.

The tray dynamic results for Tray No. 4 in Table 16 show that there are only two factors outside the standard range. The 2% overload on slots is still regarded as insignificant. The high dynamic slot seal could be compensated by decreasing the static seal. Therefore, it appears quite possible to achieve the required performance within a 13.5-ft. column.

It is noted that some of the tray dynamic factors are still far from the limit, particularly vapor distribution ratio, liquid height in downcomers, downflow residence time, and entrainment. Therefore, it is concluded that there is further opportunity for reducing the column size.

Tray Layout No. 5

Up to this point the tray development has been based on 6-in. caps. In Tray Layout No. 5, the cap size was reduced to 4 in. in order to determine whether this measure would permit the process requirements to be met in a 13-ft. column. The other design bases for this tray are the same as those of the previous layout, as shown in Table 16.

Tray Layout No. 5 is shown in Fig. 43. It was found that 576 4-in. bubble-caps could be placed on the 13-ft. tray within the standard clearances.

It will be noted in Table 16 that the tray dynamic results obtained with Tray No. 5 are considerably different from those of the previous tray. The slot load is now brought within the standard range because of the greater proportionate slot area of the smaller caps. The vapor distribution ratio has now reached the maximum limit. It will be noted that the other tray dynamic factors are tighter than previously. However, it will also be observed that only one tray dynamic factor is outside the standard range. This is dynamic slot seal, which could easily be

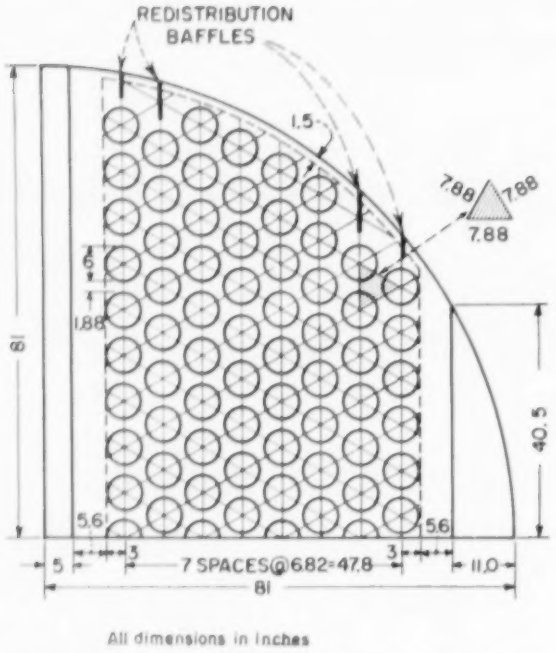


Fig. 42—**TRAY LAYOUT NO. 4**—to fit 13.5 ft. ID column

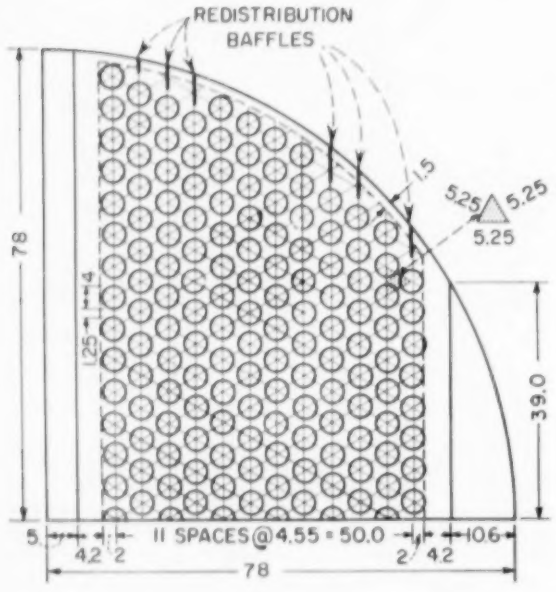


Fig. 43—**TRAY LAYOUT NO. 5**—to fit 13 ft. ID column

corrected by lowering the weir setting. Thus it is concluded that the required capacity can be obtained with a 13-ft. column.

Since the vapor distribution ratio in Tray No. 5 has reached the maximum allowable, it is apparent that any further attempt to decrease tower diameter must be accompanied by some means to improve vapor distribution. The most positive method of doing this is to step the bubble-caps at two levels.

Tray Layout No. 6

Tray Layout No. 6 was designed to be installed in a 12-ft. column. The principle new feature of this layout is the stepping of the bubble-caps at two levels, the difference between which is 0.5 in. In order to further insure against excessive liquid gradient, the skirt height was raised to 1.0 in. on the outlet rows and 1.5 in. on the inlet rows. These measures permitted the cap spacing to be reduced to 25% of the cap diameter. The static seal (on the outlet rows) was reduced to 0.5 in. to bring the dynamic seal into line. The other design bases of this layout are summarized in Table 16.

Based on these premises, the layout shown in Fig. 44 was developed. The 4-in. bubble-caps were placed on 5-in. centers, and 7 rows were set at one elevation and 5 rows at the other.

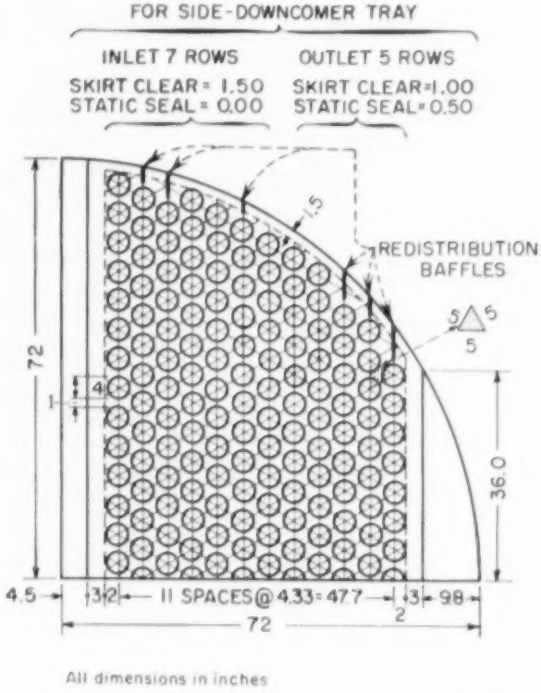


Fig. 44—**TRAY LAYOUT NO. 6**—to fit 12 ft. ID column

The following computations were made to locate the downcomers:

Tower diameter	12 ft. or 144	in.
Tower area	113.1	sq. ft.
Side downcomers:		
Weir length, (144×0.50)	72	in.
Downcomer width (Fig. 31)	$6.8\%\ D_t$	
(144×0.068)	9.8	in.
Downcomer area (Fig. 31)	$2.8\%\ A_t$	
Per downcomer, (113.1×0.028)	3.2	sq. ft.
Per tray	6.4	sq. ft.
Center downcomers:		
Length	12.0	ft.
Width	9 in. or 0.75	ft.
Area, (12×0.75)	9	sq. ft.

Details of the design of the standard 4-in. bubble-caps are given in Table 4, Part II. Two alternate riser heights, 3.0 and 3.5 in., are specified in order to provide the cap stepping.

The weir setting is found by analysis of the outlet row of caps as follows:

Skirt clearance	1.00 in.
Shroud ring	0.25 in.
Slot height	1.25 in.
Static seal	0.50 in.
Total	3.00 in.

The downflow baffle seal was set 1.0 in., and the area under the baffle determined as follows:

Clearance under baffle, (3.00 − 1.00)	2.00 in.
Area under baffle (both passes):	
Side downcomer, (2.00 × 72) × 2/144	2.0 sq. ft.
Center downcomer, (2.00 × 144) × 2/144	4.0 sq. ft.

Based on 560 bubble-caps in the 12-ft. column, the following critical tray areas were obtained:

	Per cap, sq. in.	Per tray, sq. ft. Side DC	Center DC	Avg. % of Tower Area
Riser area	4.80	18.7	18.7	16.5
Slot area	8.12	31.5	31.5	27.8
Downflow area (from only)	—	6.4	9.0	6.8
Area under baffle	—	2.0	4.0	2.7
Tower area	—	113.1	113.1	100.0

Tray Dynamics — Tray Layout No. 6

Since the tray design in Layout No. 6 is considerably different from that of No. 1, and since this is to be the final layout, example tray dynamic calculations will be given on this tray. The following calculations apply to the side-downcomer tray at maximum loading.

Mean slot opening:

$$V_m = C_v\sqrt{H_c\left(\frac{\rho_L - \rho_V}{\rho_V}\right)A_s}$$

$$= 0.74\sqrt{1.25\left(\frac{43.3 - 0.168}{0.168}\right)(31.5)} = 417 \text{ cfs}$$

Actual vapor load, (397/417)100	95.5%
Mean slot opening (Fig. 5)	97 % slot height
(1.25 × 0.97)	1.21 in.

Liquid height over weir:

Total liquid load	577 gpm
Liquid load per pass	288 gpm

$$\frac{Q}{(l_w)^{2.5}} = \frac{288}{(6)^{2.5}} = 3.3$$

From Fig. 4 $F_w = 1.04$

$$h_{ow} = 0.092F_w\left(\frac{Q}{l_w}\right)^{2/3}$$

$$= 0.092 \times 1.04\left(\frac{288}{6.0}\right)^{2/3} = 1.26 \text{ in.}$$

Bubble-cap pressure drop:

Annular riser area	1.25
K_c (Fig. 15)	0.50

$$h_{pc} = K_c\left(\frac{\rho_V}{\rho_L - \rho_V}\right)\left(\frac{V}{A_r}\right)^2$$

$$= 0.50\left(\frac{0.168}{43.3 - 0.168}\right)\left(\frac{397}{18.7}\right)^2 = 0.88 \text{ in. liq.}$$

$$h_t = h_{ow} + h_c = 0.88 + 1.21 = 2.09 \text{ in. liq.}$$

Liquid gradient: The liquid gradient across the outlet five rows of caps is obtained as follows:

Mean flow width		8.2	ft.
Liquid flow density, (288/8.2)		35	gpm/ft.
Skirt clearance		1.00	in.
Mean liquid depth	assume	4.5	in.
Uncorrected liquid gradient:			
Per row (Fig. 8)		0.130	in.
Total, (5 × 0.130)		0.65	in.
Superficial vapor velocity, (397/113.1)		3.52	ft./sec.
$u_s\sqrt{\rho_V}$, $(3.52\sqrt{0.168})$		1.44	
Vapor load correction factor (Fig. 12)	C_v =	1.16	
Corrected liquid gradient, (0.65 × 1.16)		0.76	in.

Check on mean liquid depth:

$$h_l = h_w + h_{ow} + \Delta/2$$

$$= 3.00 + 1.26 + 0.76/2 = 4.6 \text{ in. (close enough)}$$

The liquid gradient across the inlet seven rows is then calculated.

Mean flow width		11.0	ft.
Liquid flow density, (288/11.0)		26.2	gpm/ft.
Skirt clearance		1.50	in.
Mean liquid depth	assume	5.5	in.
Uncorrected liquid gradient:			
Per row (Fig. 8)		0.055	in.
Total, (7 × 0.055)		0.38	in.
Vapor load correction factor (Fig. 12)	C_v =	1.20	
Corrected liquid gradient, (0.38 × 1.20)		0.46	in.

Check on mean liquid depth:

$$h_l = 3.00 + 1.26 + 0.76 + 0.46/2 = 5.3 \text{ in. (close enough)}$$

The total liquid gradient for the tray pass is then obtained by adding the liquid gradients for the two sections:

Liquid gradient for outlet 5 rows	0.76 in.
Liquid gradient for inlet 7 rows	0.46 in.
Total liquid gradient for tray pass	1.22 in.

Vapor distribution ratio: The vapor distribution ratio between the first and last rows of bubble-caps is not necessarily the maximum ratio for the tray. In order to find the maximum vapor distribution ratio, the dynamic seal is determined for all those rows bounding a bubble-cap section, as follows:

Row (from weir)	1	5	6	12
Static seal, in.	0.50	0.50	0.00	0.00
Weir crest, in.	1.26	1.26	1.26	1.26
Gradient from weir, in.	0.00	0.76	0.76	1.22
Total dynamic seal, in.	1.76	2.52	2.02	2.48

In order to find the maximum vapor distribution ratio, the difference between dynamic seals are compared between Rows 1 and 5, 1 and 6, 1 and 12, 5 and 6, 5 and 12, and 6 and 12. By this comparison it is found that the maximum difference in dynamic seals occurs between Rows 1 and 5:

Dynamic seal at Row 5	2.52 in.
Dynamic seal at Row 1	1.76 in.
Maximum difference in dynamic seal	0.76 in.

The maximum vapor distribution ratio can then be obtained:

$$R_v = \frac{\Delta(\text{corr.})}{h_t} = \frac{0.76}{2.09} = 0.36$$

Mean dynamic slot submergence: The mean dynamic slot submergence is obtained by averaging the submergences for the bubble-cap sections:

Row 1	1.76	Mean = 2.14
Row 5	2.52	
Row 6	2.02	Mean = 2.25
Row 12	2.48	

Mean h_{sc} = 2.2 in.

Tray pressure drop: For this tray Equation 62 is not appropriate for the computation of pressure drop because of the stepped caps. Instead, the following equation is employed:

$$h_t = h_c + \overline{h_{ss}} = 2.09 + 2.2 = 4.3 \text{ in. liq.}$$

Liquid height in downcomer:

$$h_d = 0.03\left(\frac{Q}{100A_s}\right)^2$$

$$= 0.03\left(\frac{288}{100 \times 1.0}\right)^2 = 0.25 \text{ in.}$$

$$H_d = h_w + h_{ow} + \Delta + h_d + h_t$$

$$= 3.00 + 1.26 + 1.22 + 0.25 + 4.3 = 9.9 \text{ in.}$$

Available downflow height, (24.0 + 3.0)	27.0 in.
Height clear liquid, (9.9/27.0)100	37%

Downflow residence time:

Downflow area (per pass)	3.2 sq. ft.
Tray spacing	2.0 ft.
Downflow volume, (3.2 × 2.0)	6.4 cu. ft.
Liquid flow rate (per pass), (1.29/2)	0.64 cfs
Downflow residence time, (6.4/0.64)	10 sec.

Liquid throw over weir:

$$h_f = T + h_w - H_d$$

$$= 24 + 3.0 - 9.9 = 17.1 \text{ in.}$$

$$t_w = 0.8\sqrt{(h_{ow})(h_f)}$$

$$= 0.8\sqrt{(1.26)(17.1)} = 3.6 \text{ in.}$$

Downflow width	9.8 in.
Liquid throw, (3.6/9.8)100	37%

Entrainment:

Tower area	113.1 sq. ft.
Downcomer area:	
Side downcomers (per tray)	6.4 sq. ft.
Center downcomer	9.0 sq. ft.
Total (from and to)	15.4 sq. ft.
Available flow area (A_f), (113.1 − 15.4)	97.7 sq. ft.
Vapor velocity (u_f), (397/97.7)	4.07 ft./sec.

Abscissa in Fig. 18:

$$x = \frac{27.3}{T} + 10.75u_f\sqrt{\frac{\rho_v}{\rho_L - \rho_v}}$$

$$= \frac{27.3}{24} + 10.75 \times 4.07\sqrt{\frac{0.168}{43.3 - 0.168}} = 3.87$$

Interfacial tension	21 dynes/cm.

Ordinate in Fig. 18:

$$y = 1.50 = \frac{G_t}{h_{ow} + h_{ss} + h_c}$$

Entrainment:	
Static seal, outlet rows	0.50 in.
Static seal, inlet rows	0.00 in.
Mean static seal	0.25 in.

$$G_t = 1.50(h_{ow} + h_{ss} + h_c)$$

$$= 1.50(1.26 + 0.25 + 1.21) = 4.1 \text{ lb./min.-sq. ft.}$$

$$4.1 \times 97.7 = 400 \text{ lb./min.}$$

Vapor load	4,000 lb./min.
Entrainment ratio, (400/4,000)	0.10 mol/mol dry vapor

Entrainment quotient:

$$R_e = \frac{eE_d}{R} = \frac{0.10 \times 0.70}{0.833} = 0.084$$

Plate efficiency:

Local dry plate efficiency	0.70

Local wet plate efficiency:

$$E_{ow} = \frac{E_d}{1 + \frac{eE_d}{R}} = \frac{0.70}{1 + \frac{0.10 \times 0.70}{0.833}} = 0.65$$

Length of liquid path (12 rows)	4 ft.
Number of stages for moderate mixing (Fig. 20)	3.5

Overall plate efficiency:

$$E_o = R\left[\left(1 + \frac{E_{ow}}{nR}\right)^n - 1\right]$$

$$= 0.833\left[\left(1 + \frac{0.65}{3.5 \times 0.833}\right)^{3.5} - 1\right] = 0.85$$

These tray dynamic calculations are then repeated for the center-downcomer tray at maximum loads.

Finally, the tray dynamic calculations are repeated for both side and center-downcomer trays at minimum loads, following the same procedures.

Summary—Tray Layout No. 6

The complete tray dynamic results for Tray No. 6 are summarized in Table 16. At maximum loads, it will be observed that every tray dynamic factor is within the standard range for both side and center-downcomer trays, with the exception of the mean dynamic seal on the side-downcomer tray, which is 2.2 in. as compared with the standard of 2.0 in. maximum. However, this is of no concern except with respect to pressure drop, and the tray pressure drop of 4.3 in. of liquid is regarded as quite reasonable for atmospheric operation.

It will be observed, further, that almost every tray dynamic factor is pushed to approach the limit. This is even true of entrainment, which in the case of the side-downcomer tray has now reached the maximum allowable.

Therefore, it is concluded that we have now attained the smallest practical tower diameter possible within the standard range of tray dynamic factors.

The check on tray dynamics at minimum loads demonstrates that all tray dynamic factors are safe for these conditions also. Therefore, it is concluded that the tower will provide adequate performance at both maximum and minimum anticipated loads.

Comparison and Evaluation

Table 16 provides a comparison and evaluation of the 6 tray layouts studied. This study started with a 15-ft. column, and ended with a 12-ft. column, which represents a total reduction in column area of 36%.

From a standpoint of tray dynamics alone, it appears that any of Trays 2 through 6 will provide satisfactory performance.

On the basis of tower diameter alone, it would appear that Tray Layout No. 6 is the most attractive. However, the designer should not jump to conclusions, because it has been pointed out previously that fractionator costs depend on bubble-cap size, cap spacing, tray type, and plate efficiency as well as tower diameter.

The true criterion of optimum tray design is the attainment of required performance at minimum cost.

Table 17—Specifications for final tray

A. Materials of construction

1. Type	sheet metal
2. Material	
a. Tray	mild carbon steel
b. Bubble-caps	mild carbon steel

B. Type of tray — double-pass

C. Bubble-cap design

1. Type and shape	round, bell-shaped
2. Cap	
a. Thickness	12 U. S. Standard gage
b. Outside diameter	4.093 in.
c. Inside diameter	3.875 in.
d. Height overall	3.000 in.
e. Number of slots	26
f. Type of slots	trapezoidal
g. Slot width	
Bottom	0.333 in.
Top	0.167 in.
h. Slot height	1.250 in.
i. Height shroud ring	0.250 in.
j. Skirt height	
Side-downcomer trays	
Inlet 7 rows	1.50 in.
Outlet 5 rows	1.00 in.
Center-downcomer trays	
Inlet 5 rows	1.50 in.
Outlet 7 rows	1.00 in.
3. Risers	
a. Thickness	12 U.S. Standard gage
b. Outside diameter	2.718 in.
c. Inside diameter	2.500 in.
d. Height	
For 1.00-in. skirt clearance	3.00 in.
For 1.50-in. skirt clearance	3.50 in.
4. Riser-slot seal	0.50 in.
5. Assembly	bolt hold-down, removable from above tray

D. Downcomer design

1. Type	
a. Side	segmental
b. Center	rectangular
2. Number	
a. Side	2
b. Center	1
3. Tray spacing	24 in.
4. Downflow baffle	vertical
5. Baffle clearance to tray	2.00 in.
6. Tray support rings	eliminated through downcomer

E. Tray layout

1. Column ID to fit	144.0 in.
2. Inlet Weirs	none
3. Outlet weirs	
a. Location	
Side	9.8 in. from tower wall
Center	4.5 in. from tower center
b. Type	straight
c. Length	
Side	72 in.
Center	144 in.
d. Design height setting	3.00 in.
e. Adjustable range	2.00-4.00 in.
4. Cap layout	
a. Number of caps	560 minimum
b. Number of rows normal to flow	12
c. Cap pitch	equilateral triangular
d. Cap spacing	5.00 in. center to center
e. Clearances	
To weirs	3.0 in. minimum
To downflow baffles	3.0 in. minimum
5. Distribution baffles	
a. Location	all rows where end clearance to tower wall exceeds 2.0 in.
b. Clearance to caps	1.0 in.
c. Height	8 in.

F. Tray design

1. Type of tray design	removable through 20-in. manway
2. Tray design deflection under load	0.125 in.
3. Drain holes	
a. Diameter	0.50 in.
b. Number per tray	20
c. Location	16 at outlet weirs, 4 spotted generally
4. Tray packing	asbestos tape with woven edges

G. Construction tolerances

1. Tray levelness	0.25 in. max. from lowest to highest points
2. Weir levelness	0.125 in. max. from lowest to highest points
3. Tray leakage	max. fall 1.0 in. water from top of weir (3.00 in.) in 20 min. with drain holes plugged

Cost Evaluation

Therefore, the 6 tray layouts were evaluated to determine the relative economics. The cost estimates developed included a consideration of:

1—Effect of tower diameter
2—Effect of size and number of bubble-caps
3—Effect of cap spacing and stepping
4—Effect of tray design on plate efficiency, number of plates, and tower height
5—Effect of tray type, including accessories

In each case, the total fractionator cost was determined for a tower providing the equivalent of 40 theoretical plates. The costs were developed for the fractionator completely fabricated, with the trays installed, but not including erection.

The results of this cost evaluation are presented in Table 16.

The cost of Tray No. 1 is ignored because this layout does not meet the process requirements. It will be observed that in proceeding from Tray No. 2 to Tray No. 3, the savings indicated by reducing the tower diameter from 15 to 14 ft. are entirely eaten up by the additional cost per sq. ft. of the double-pass tray and the loss in plate efficiency.

In going from Tray No. 3 to Tray No. 4, there are slight savings as a result of reducing tower diameter from 14 to 13.5 ft.

In going from Tray No. 4 to Tray No. 5, there are no savings because the benefit of reducing tower diameter from 13.5 to 13.0 ft. is compensated by the added cost per sq. ft. because of the smaller bubble-caps.

■ Bubble-Cap Tray Design—Part IV

In proceeding from Tray No. 5 to Tray No. 6, where the tower diameter was reduced from 13 to 12 ft., the full economic benefits of tight tray design are finally realized, and the true optimum tray corresponding to minimum fractionator cost is achieved.

Thus, the study began with the most expensive satisfactory Tray, No. 2, at an estimated cost of $113,000, and the tray development proceeded to the most economical design, No. 6, estimated at $96,000. The economic savings resulting from this tray development were then about $17,000 or 15%.

These are not the entire savings due to the tray development. Other real savings not included above will be found in:

1—Foundations
2—Structures
3—Erection
4—Insulation
5—Painting
6—Space requirements

Specifications for Final Tray

Following Table 1, Part I as a guide, the complete specifications for the final tray design are prepared as shown in Table 17. These specifications are now ready to send out for bids.

Performance Chart for Final Tray

A performance chart was developed for the final tray to show the area of operation with respect to vapor and liquid loads where satisfactory performance may be expected. Such a performance chart indicates the operating flexibility of the tray.

The performance chart was developed by means of tray dynamic calculations on the basis of the limits of tray dynamic standards given in Part II.

The performance chart was calculated for the top tray of the example fractionator, assuming this to be a side-downcomer tray.

The resulting performance chart is presented in Fig. 45. Here, it will be noted that the area of satisfactory operation is bounded by conditions of:

1—Overloaded slots
2—Excessive entrainment
3—Flooding
4—Bad vapor distribution
5—Insufficient downflow residence time
6—Vapor pulsation
7—Insufficient slot submergence

In this particular tray, conditions of flooding and insufficient downflow residence are very remote with respect to the other limiting conditions. This is not always true.

Also shown in Fig. 45 are points corresponding to the maximum and minimum load requirements for the example case. The performance chart indicates that satisfactory operation can be expected at all points between maximum and minimum loads.

With the 3-in. weir setting, an area of unsatisfactory operation corresponding to insufficient slot submergence is indicated at low liquid loads. However, the area of satisfactory operation may be extended to zero liquid load by simply raising the outlet weirs. This demonstrates one advantage of adjustable weirs.

The attention of the reader is called to the very wide flexibility of the bubble-cap tray as demonstrated in Fig. 45. It should be realized that the area of satisfactory operation indicated on this chart is estimated very conservatively. Actually, it is believed that fairly satisfactory operation can be obtained considerably outside the area indicated. Many sets of performance data on commercial fractionators have proved this.

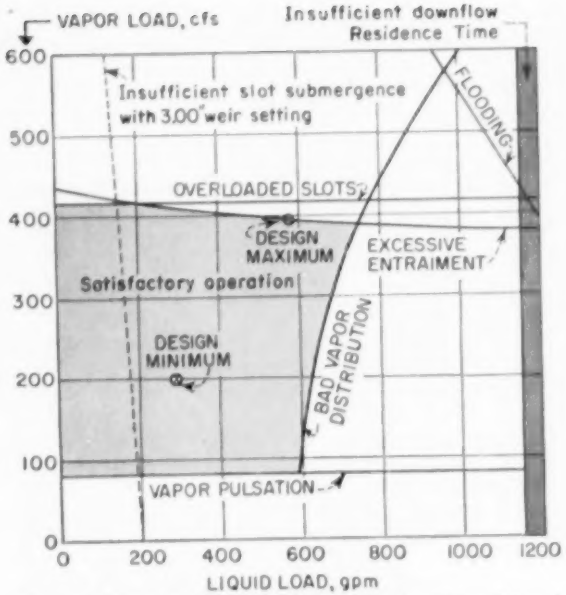


Fig. 45—**TRAY PERFORMANCE CHART** for Tray Layout No 6—side downcomer

Another way of stating this is to say that the limits drawn in the tray performance chart are not very precise because of the approximate nature of the tray dynamic calculations and standards. The area of satisfactory operation outlined should correspond to the plateau of maximum plate efficiency. It is believed that satisfactory operation at slightly lower plate efficiencies extends somewhat outside the area outlined.

It must be realized that the geometric configuration of the tray performance chart presented in Fig. 45 applies only to the example case and the particular tray design studied. The configuration of the tray performance chart varies from case to case. For example, another typical tray performance chart is shown in Fig. 30, Part II.

The construction of a performance chart is not recommended as a routine procedure in the design of bubble-cap plates. This chart was prepared only to illustrate the relations among tray dynamic variables, and to demonstrate the very wide operating latitude of bubble-cap trays.

As the final thought, it is hoped that future experimental work on bubble-cap tray dynamics will result in more reliable calculation methods, so that the "standard" acceptable ranges of tray dynamics may be extended without risk of sacrificing performance. Such developments would permit even further savings in bubble-cap fractionator sizes and costs.

—THE END—

Reprints Are Available

. . . of this four-part article, "New Process Design Methods for Optimum Bubble-Cap Tray Design," by W. L. Bolles, concluded in this issue. Single copies, $1.50. Special rates for quantity orders on request. To order, see Readers' Service Card, p. 176 this issue, or address orders to: Reprint Dept., PETROLEUM PROCESSING, 330 West 42nd St., New York 36, N.Y.

Start Right...

Stay Right

WITH MEX-R-CO "plus factor" CASTABLES

START RIGHT...

by selecting the proper MEX-R-CO Castable for your specific conditions. There is a Special volume-stable MEX-R-CO Refractory Castable for every refinery vessel, lining or heater application:

- High-Strength
- Low-Iron
- High-Alumina
- Light-Weight (Insulating)
- Heavy-Weight
- Tabular

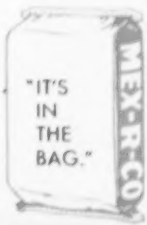
Then...STAY RIGHT!

Under the wide range of operating conditions encountered in the refinery industry—abrasion, erosion, catalyst poisoning, reducing atmospheres, K-factor in presence of hydrogen, increasing pressures and varying atmospheres—MEX-R-CO Castables give that "plus factor" service which means the difference between costly interrupted operation and trouble-free days on stream.

MEX-R-CO'S advanced Research and Engineering facilities are meeting refining industry requirements. You are invited to use our Material-selection, Engineering and Installation-supervision services. Write us today . . .

For Top Quality in Refractory Castables, Buy MEX-R-CO . . .

MEX-R-CO



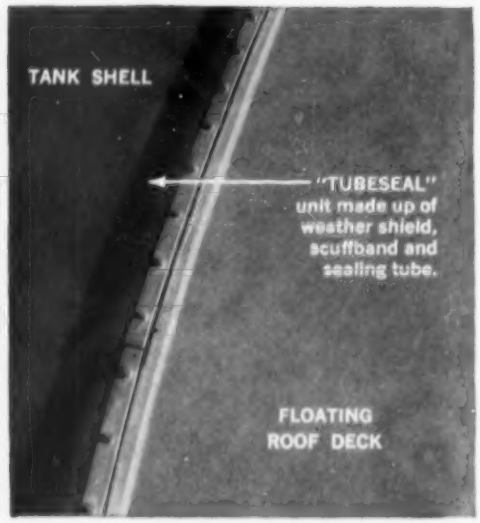
MEXICO REFRACTORIES COMPANY
MEXICO, MISSOURI
Divisions: NILES FIRE BRICK CO., Niles, Ohio • NATIONAL REFRACTORIES CO., Philadelphia, Pa.
Canadian Affiliate: REFRACTORIES ENGINEERING & SUPPLIES, LTD., Hamilton, Ontario, Canada

RESULTS CONVINCED

In 1954 the "X" Company* bought

TO DATE THEY HAVE PURCHASED 20 ADDITIONAL TUBESEALS

...on the basis of proved performance!



Looking down on Hammond Tubeseal in position on Floating Roof tank. Neoprene weather shield and ribbed scuffband protect oil-filled sealing tube, which is in continuous contact with product, thereby eliminating vapor space.

* **One of the nation's largest oil companies. Name on request.**

† **Patented**

UNUSUAL? No, merely typical of the many new users who are adding fresh chapters to Tubeseal's exciting "success story." And no wonder! Tubeseal is the **only** floating roof that eliminates vapor space while providing a **positive** seat at all points between the roof, shell and product. No vapor-air mixture can lurk above the product—because there is no space for vapor to form.

Think of the advantages this offers! Regardless of the product you are storing—vapor losses simply can't occur. And with products of intermediate volatility, such as jet fuels, the dangers of exploding vapors and rim fires are practically non-existent.

NO CORROSION
NO MECHANICAL MAINTENANCE
CLIMATE PROOF

In contrast to conventional metal shoe seals, where rusting and corrosion shorten seal life and create contamination, the Tubeseal is completely non-corroding. Nor will it scuff, abrade or injure the interior tank surface. And because it has no moving parts, there is no mechanical maintenance required.

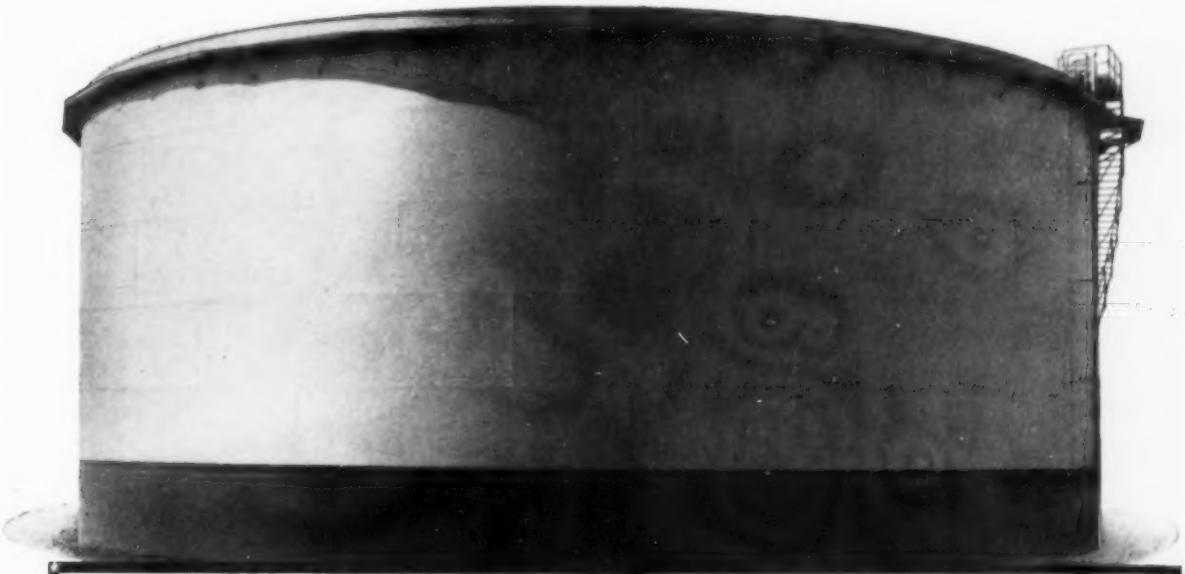
Tubeseal Floating Roofs can be efficiently used on all types of new and existing tanks—even those of riveted construction where metal shoe seals are particularly inadequate. The liquid-filled tube quickly adjusts to irregular shapes, overcoming any tank out-of-roundness.

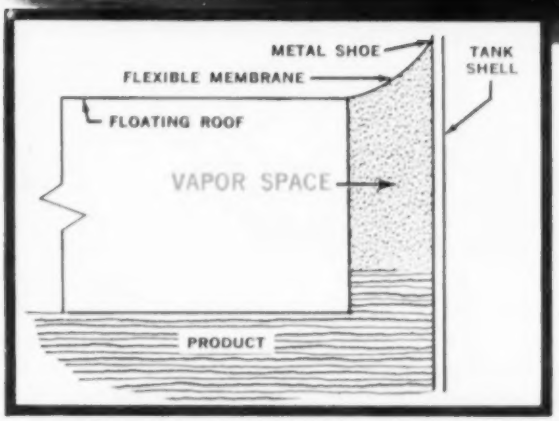
Whether you are storing gasolines, jet fuels, sour crudes, light crudes, alcohol, naphthas, polyesters or similar products, Tubeseal is **the most efficient and positive seal known.**

BUILT TO YOUR SPECIFICATIONS...GUARANTEED TO YOUR SATISFACTION!

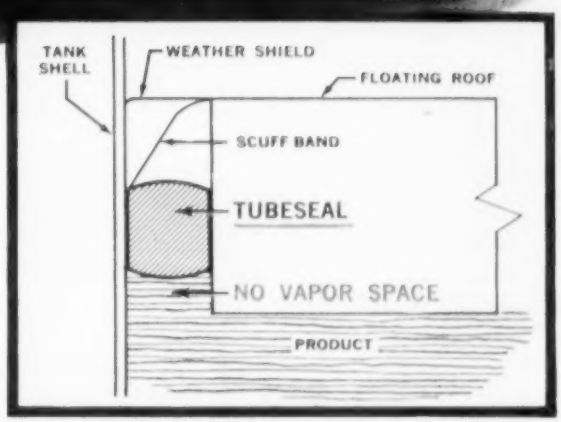
THIS MAJOR REFINER*...

ONE Tubeseal† Floating Roof Tank





Conventional floating roof tank has space between flexible membrane where air-vapor mixtures form. Because metal shoe and membrane cannot be absolutely gas tight, vapor is constantly escaping. This condition causes excessive corrosion, may also result in fire from lightning or other source.



HAMMOND TUBESEAL FLOATING ROOF entirely eliminates every space where air-vapor mixtures can form. **Hammond Tubeseal** completely fills space between product surface and roof seal, so that corrosion is stopped (even for sour crudes), and vapors **cannot form**—hence **cannot ignite or be lost.**

HAMMOND TUBESEAL COSTS NO MORE IN THE FIRST PLACE

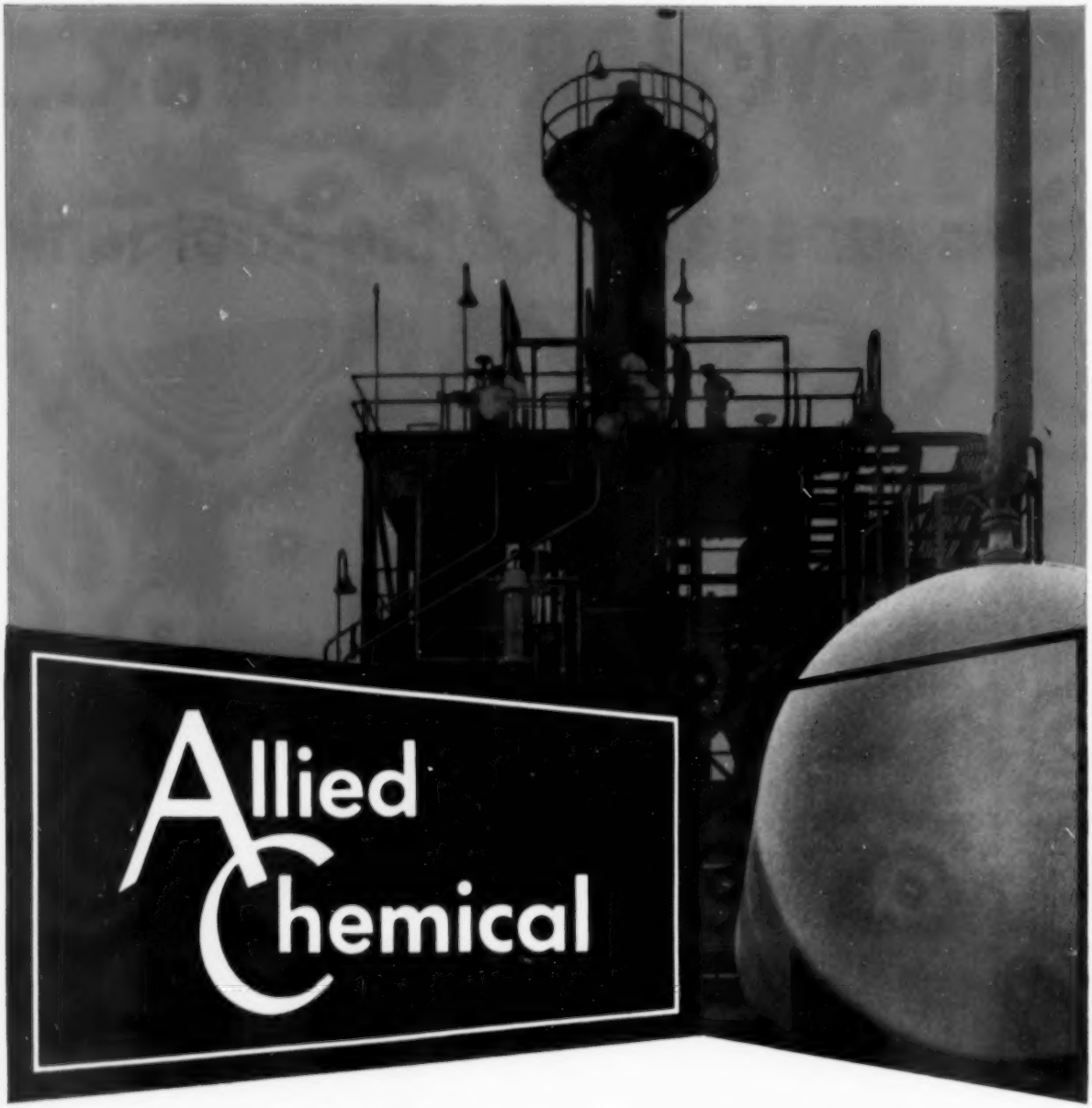
HAMMOND IRON WORKS

WARREN and BRISTOL, PA. • PROVO, UTAH • CASPER, WYO. • BIRMINGHAM, ALA.

Sales Offices:

BOSTON 10, MASS. • NEW YORK 20, N. Y. • CINCINNATI 2, OHIO • CHICAGO 3, ILL. • WARREN, PA. BRISTOL, PA. • ARLINGTON, VA. • GREENVILLE, S. C. • BIRMINGHAM, ALA. • SAGINAW, MICH. SAPULPA, OKLA. • PROVO, UTAH • CASPER, WYO. • LOS ANGELES 57, CALIF. • HAVANA • MEXICO CITY "TIPSA," BUENOS AIRES • CAIRO, EGYPT • PORT-AU-PRINCE, HAITI • LIMA, PERU

Licensees: **CALIFORNIA, CANADA, GERMANY, ITALY, FRANCE, JAPAN**



ETHANOLAMINES

Treating gas with mono or diethanolamine? Allied's Orange, Texas, plant—most modern in the industry—can supply you with ethanolamines consistently above standard specifications. Shipments in tank cars, tank trucks or 55-gallon drums available from Orange, Texas. Nationwide stocks for delivery by tank truck and 55-gallon drums. Phone or write for samples, quotations, literature, technical service with no obligation.

EA 2-20-2

Allied Chemical — NITROGEN DIVISION

40 Rector Street, New York 6, N. Y.

Ethanolamines • Ethylene Oxide • Ethylene Glycols • Urea • Formaldehyde • U. F. Concentrate—85 • Anhydrous Ammonia • Ammonia Liquor • Ammonium Sulfate • Sodium Nitrate • Methanol • Nitrogen Solutions • Nitrogen Tetroxide • Fertilizers & Feed Supplements

 (To obtain more data on advertised products see page 174)

Your Guide to . . . Petroleum Processing Departments

Keep Your Data File Up-to-Date

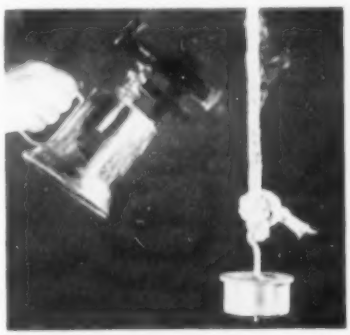
Are you using these two new departments to maintain your information files? They are designed for your convenience – perforated so you can remove them from the magazine quickly and easily. And punch holes have been indicated so you can file them in loose-leaf binders. Keep them each month and build up your own personal process and engineering data book. The subjects this month are:

"Clip-n-File" Process Data —
Chemico Urea Synthesis
. . . using excess ammonia for high conversion. Full process data, tables, and a schematic flow diagram. **p. 128**

"Clip-n-File" Engineering Data —
Tank Capacity Tables
. . . for vertical, cylindrical tanks, in bbls. and gals., from diameter and height, in ft., plus a helpful nomograph for fast conversions. **p. 141**

Getting Everything You Have Coming?

Our Readers' Service system has been augmented for your convenience. Do you want extra copies of some of our popular reprints of recent feature articles? Use the handy card. It's a fast, easy way to get your orders taken care of. **p. 175**



Ceramic Rope Resists 2300° F.

A new aluminum-silicate ceramic fiber in rope form for use in caulking and in expansion joint packing. It has long staples, is resilient and light in weight. Only one of 50 or more new products, new equipment, and new ideas in What's New! **p. 177**

It's Not a "Side-Winder"

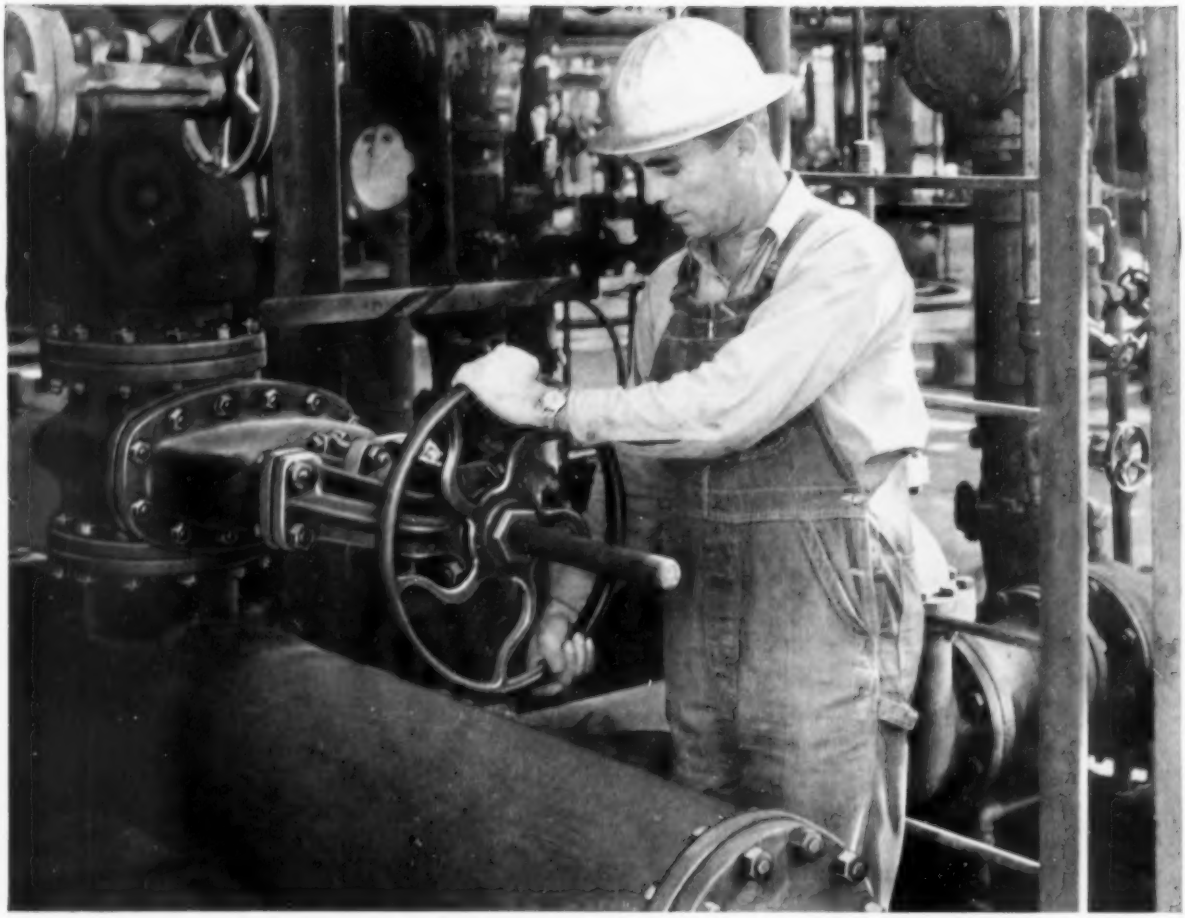
But it is a side-loader. Here's a stunt to lick the problem of handling awkward loads – long pipe, tube bundles, and the like. There are also four other ideas in shop-engineered gadgetry. Turn to the regular department, Plant Practices. **p. 133**

Two New Books for Your Shelves

This month's Book Reviews discusses two new ones on analytical chemistry: Belcher and Wilson on gravimetric and titrimetric analysis, and Wagner, Hull, and Frankel, who have developed a systematic review of advances in analysis. **p. 167**

INDEX TO DEPARTMENTS

Advertisers' Index	174
Book Reviews	167
Editorials	208
Engineering "Clip-n-File" Data	141
Equipment — What's New!	177
Information Offered	173
Meetings	155
New Words	139
Operating Trends	169
Patents	159
Personals	145
Plant Practices	133
Process "Clip-n-File" Data	128
Readers' Service Card	175
Statistics — Operating Trends	169
Suppliers	149
What's New!	177



No leakage, no sticking with this Crane valve after 2 years on heavy alkylate at 300° F.

THE CASE HISTORY—How do Crane cast steel gate valves hold up on heavy alkylate? The No. 47X 10-inch, 150-pound valve you see above has been in service at Eastern States Petroleum Co. refinery at Houston for over two years.

It handles re-run bottoms from the H_2SO_4 alkylation unit at 300° F. In addition to erosion from solid carbon, there is mild corrosion present from acid. Valve operation is on an average of once every 1½ weeks.

Not once has Eastern States had to put a wrench on this Crane valve. There has been no leakage, no sticking whatsoever. Closure is tight and sure, and response to the handwheel is as smooth and easy as the day the valve was installed.

Unusual performance? Not for Crane cast steel gate valves. For these valves differ from other valves on the *inside*—where performance stands or falls.

Over a century of skill is back of their sound design and pressure-tight castings, and in the heat treating and finishing of the Crane Exelloy seating. That's why Crane valves are *preferred* for refinery service.

Whatever you need in refinery valves—gates, globes, angles and checks—screwed, flanged or welding ends—sizes up to 24 in.—in pressure classes up to 2500 psi.—check with Crane first.

Call your local Crane Representative for valuable help in specifying and ordering, or write to address below.

CRANE VALVES & FITTINGS

PIPE • KITCHENS • PLUMBING • HEATING

Since 1855—Crane Co., General Offices: Chicago 5, Ill. Branches and Wholesalers Serving All Areas

Process—Synthesis of urea from liquid NH_3 and CO_2.

Process Chemistry—The basis for the Chemico urea process (and for all modern commercial scale urea manufacture) is the non-catalytic reaction of NH_3 and CO_2 under pressure and elevated temperature to form the reaction intermediate— ammonium carbamate—as follows:

$$CO_2 + 2NH_3 \rightleftharpoons NH_2COONH_4$$

Some of the ammonium carbamate breaks down to form urea and water (varying with operating conditions, up to a maximum of 40-50% for stoichiometric proportions of reactants—higher when excess NH_3 is present) as follows:

$$NH_2COONH_4 \rightleftharpoons NH_2CONH_2 + H_2O$$

The overall result of the above reactions is exothermic. Both of the above reactions are reversible, but urea is stable relative to ammonium carbamate. Therefore, the application of reduced pressure and heat to the reaction mixture (urea, water and unconverted ammonium carbamate) selectively decomposes the carbamate into its constituents of NH_3 and CO_2. The NH_3 in this stream can be used for the manufacture of other chemicals such as $(NH_4)_2SO_4$, or can be recovered and recycled to the reaction autoclave. CO_2 is normally vented to the atmosphere, but can also be recycled.

There are several commercial versions for recovering and recycling NH_3 and CO_2 from carbamate decomposition, but the discussion here will be limited to the Chemico process cycle (see Complete Recycle Operation).

Process Flow, Partial Recycle Operation—The basic Chemico urea synthesis may be operated on a partial recycle basis with recycle of only the excess NH_3.

The feed preparation portion of the process shown on the schematic flow diagram consists primarily of the compression and liquefaction equipment. The synthesis section consists of the reaction autoclave, the excess NH_3 separator tower, and the carbamate decomposer.

Liquid NH_3 and CO_2 in about a 6:1 mol ratio (a 200% excess of NH_3 over stoichiometric to increase conversion to urea—see Operating Variables) are charged to the urea reaction autoclave. Net heat produced in the reaction preheats the excess NH_3 to reaction temperature—eliminating the need for heat transfer in the autoclave.

Reaction effluent (urea, water, unconverted carbamate and unreacted excess NH_3) flow under reduced pressure to the separator, where distillation removes most of the excess NH_3 as overhead product. This NH_3 gas is CO_2-free, and therefore no solid carbamate plugs can be formed in the NH_3 condenser. After condensation, the NH_3 is sent to reaction autoclave with makeup NH_3.

Bottoms from the excess NH_3 separator, consisting of urea, water, free NH_3 and unconverted carbamate, are fed at reduced pressure to a carbamate decomposer. Here the application of heat causes the carbamate to break down to CO_2 and NH_3 gases. The NH_3 can then be used directly for fertilizer manufacture, or can be separated for recycle to the reaction autoclave (see Complete Recycle Operation).

For prilled product, aqueous urea solution leaving the bottom of the decomposer is concentrated in a vacuum evaporator and then sent to the prilling system. Aqueous urea solution can also be used to produce crystals.

Complete Recycle Operation—For recycle operation, the decomposer gases are sent to the CO_2 absorption column. CO_2 is removed by monoethanolamine solution. Absorber overhead is gaseous NH_3 to be compressed and liquefied for recycling to the reaction autoclave. Absorber bottoms containing CO_2 are sent to a solvent regenerator for CO_2 desorption. Regenerated MEA solution is returned to the top of the CO_2 absorber.

Raw Materials—Essentially pure CO_2 and anhydrous NH_3 are the raw materials for urea synthesis. Fresh NH_3 (as specified in Table 1) should be commercial grade, or the equivalent (99.5% pure). If necessary to meet the specifications of Table 1, the CO_2 can have the last traces of sulfur compounds removed by activated carbon and oxygen removed by platinum catalyst. Inert gases in the CO_2 are removed in the liquefaction step.

Product—Consists of a water solution of urea which can be used directly for making liquid fertilizers, or can be processed into prills containing a minimum of 46% nitrogen (including the anti-caking agent content), or crystals of high purity as required for plastics manufacture.

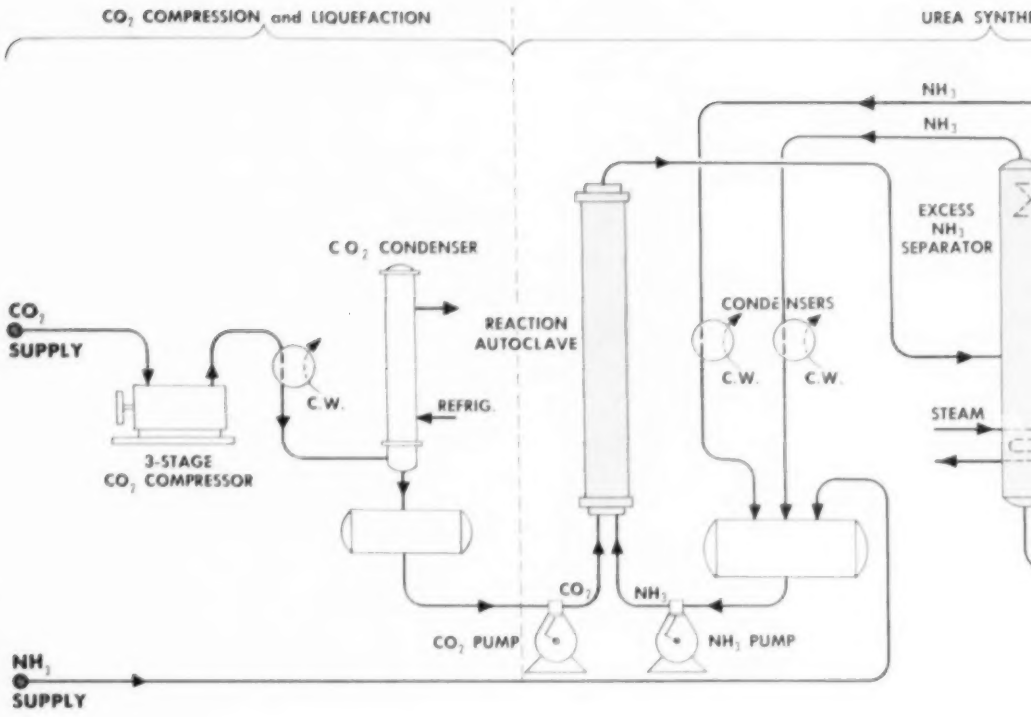
Yields, when using the 200% excess NH_3 in the reaction, are 0.76 mol urea/mol CO_2 feed, compared to around 0.45 mol urea/mol CO_2 feed when using stoichiometric proportions of NH_3 and CO_2 in the reaction autoclave.

Operating Conditions—Temperature in the urea synthesis autoclave is 175-185°C (347-365°F) and pressure is about 280 atm. (approximately 4100

Table 1—Specifications for NH_3 and CO_2 Feed to Chemico Urea Synthesis Process

Carbon Dioxide Gas	
Oxygen	10 ppm maximum
Sulfur compounds (S)	1 ppm maximum
Carbon monoxide	0.1% maximum
Inerts*	1% (approximately)
Carbon dioxide	remainder
Liquid Ammonia (commercial grade purity)	
Ammonia	99.5% minimum
Water	0.5% maximum
Oil	5 ppm maximum

*Increased inerts in the CO_2 feed will increase throughput and compression requirements for the process.



psig). NH_3 is used in 200% excess of stoichiometric requirements (see Operating Variables).

The excess NH_3 separator tower is operated at a pressure sufficient to allow liquefaction of the overhead NH_3 gas by available cooling water.

Operating Variables—Feeding a stoichiometric mixture of NH_3 and CO_2 (2:1 mol ratio) to the reaction autoclave limits conversion to urea to a maximum of 40-50%. The use of 200% excess NH_3 (6:1 mol ratio of NH_3:CO_2) increases theoretical conversion to urea to 83% at 175°C—actual conversion is about 76%.

Using excess NH_3 means that more NH_3 must be pumped to the reaction autoclave, and additional equipment is needed to separate and condense the surplus NH_3. However, these factors are more than compensated for by a decrease in the ammonium carbamate to decompose, gas to separate and NH_3 to compress. CO_2 compression requirements are also reduced.

Equipment—As previously mentioned (see Process Flow, Partial Recycle Operation) no heat transfer is needed in the reaction autoclave because of the excess NH_3 used in the system. The autoclave is lined to withstand the highly corrosive reaction conditions.

Operating Requirements—For a complete recycle type of Chemico urea synthesis plant producing

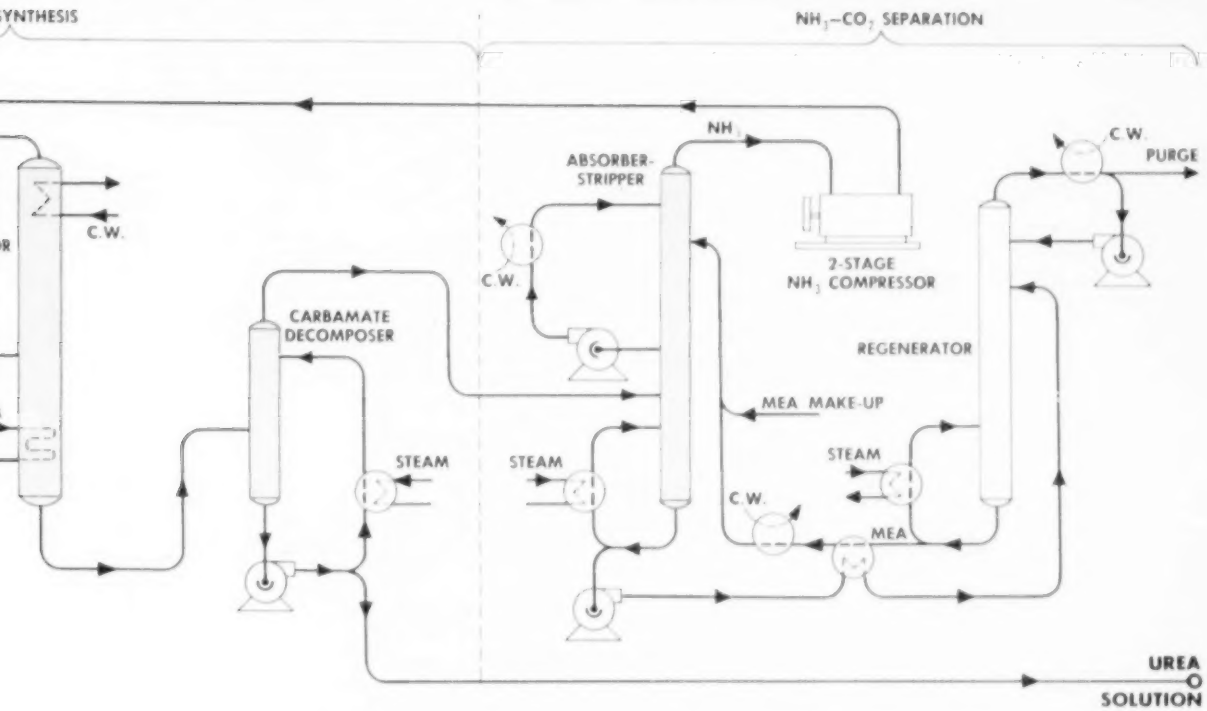
Table 2—Operating Requirements for a Chemico Urea Plant Producing 150 tons of prills/day

The following operating requirements are nominal and can vary, depending upon site and other conditions corresponding to a specific installation.

	Partial Recycle	Complete Recycle
Materials (per ton of urea produced)		
Liquid NH_3, tons	0.58[1]	0.59
CO_2 gas, tons	1.1[2]	0.78[3]
Solvent make-up (MEA), lbs.	—	0.16
Utilities (per ton of urea produced)		
Electric power, kwh.	175	240
Cooling water (85°F), gals.	26,000[4]	45,000[5]
Steam (150 psig), lbs. [6]	4,000	7,300
Refrigeration (depends on specific conditions)		

(1) 0.97 feed; 0.58 net consumption; 0.39 to fertilizer manufacture; units, tons NH_3/ton urea.
(2) A mixture of NH_3 and CO_2 is sent to the fertilizer operation. This CO_2 requirement is based on no CO_2 recovery at the fertilizer operation.
(3) Assumes CO_2 recovery and recycle to the reaction autoclave. Without CO_2 recycle, CO_2 consumption is 1.1 tons/ton urea product.
(4) For 15°F temperature rise on cooling water.
(5) For 18°F temperature rise on cooling water.
(6) Most of the steam is recovered as condensate, and returned to the steam plant.

NOTE: The above quantities are based on CO_2 feed at 2 psig and 100°F maximum and NH_3 feed at 250 psig and 100°F maximum—both meeting the specifications in Table 1.



Chemico Urea Synthesis

. . . using excess NH_3 for high conversion

UNFOLD **FOR START OF PROCESS DESCRIPTION**

150 ton/day urea. Table 2 gives operating requirements for both partial recycle and complete recycle operation for making prilled urea product. These requirements are nominal and can vary depending upon site and other conditions corresponding to a specific installation.

Economics—Estimated investment for a Chemico urea synthesis plant erected in the United States, and producing 150 ton/day bagged, prilled urea (complete recycle operation basis) is under $2.5 million. This is a nominal investment cost and can vary depending upon a specific installation. This figure assumes an erected plant with all necessary process equipment, instruments and controls, battery limits utility piping and controls, and buildings and foundations. Also included are paid-up royalties, training of operating personnel, and supervision of initial start-up.

When installing a urea plant adjacent to an existing fertilizer unit, such as an $(NH_4)_2SO_4$ plant the gaseous NH_3 from carbamate decomposition may be used as a raw material. In this arrangement the ammonium sulfate plant is used as an ammonia recovery unit. The investment cost of the urea plant may be reduced about 20% due to the fact that the ammonia—CO_2 separation system using MEA is then not required. However, even in this type of partial recycle urea plant, excess NH_3 is used in the reaction to give high conversion of carbamate to urea.

Costs for CO_2 are considered zero, when the urea plant is located adjacent to an NH_3 plant from which CO_2 is readily available.

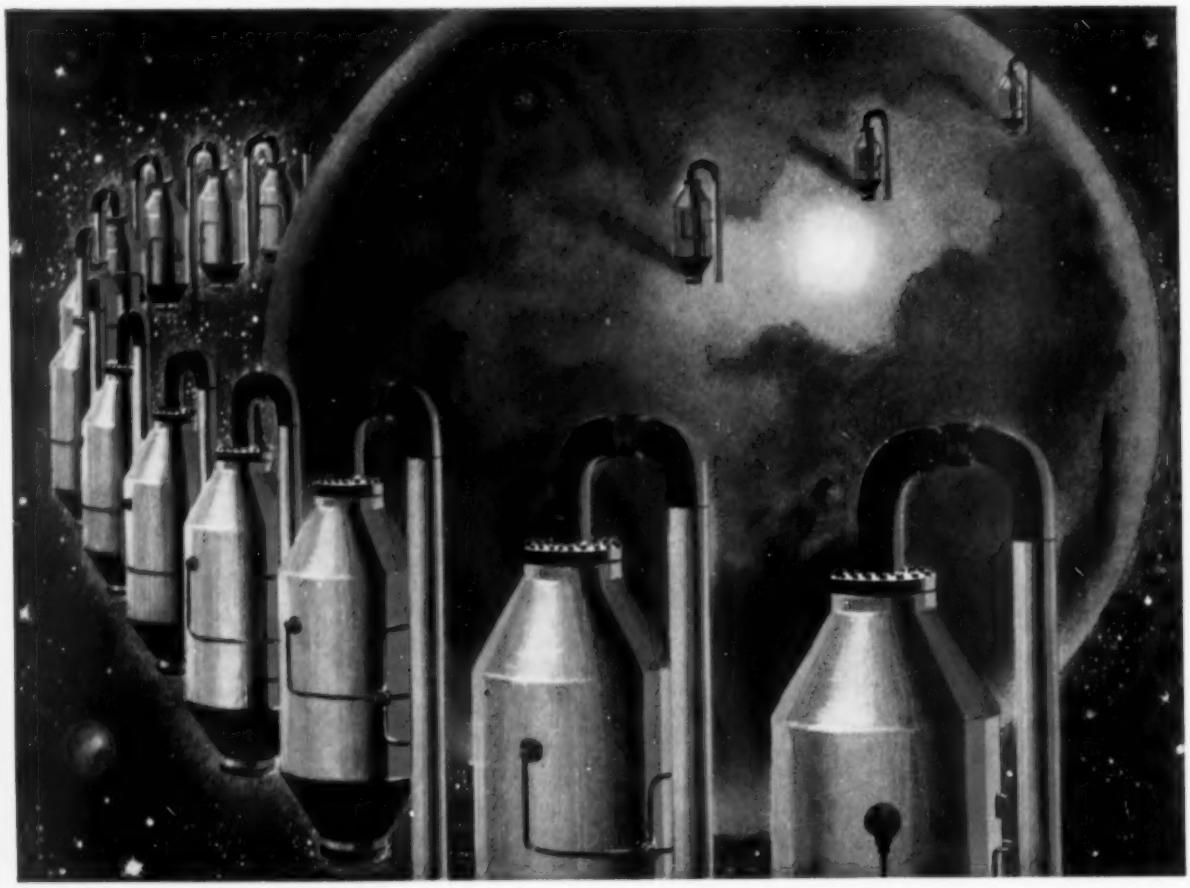
Installations—The first Chemico urea synthesis plant was built in 1952 for the Sumitomo Chemical Co., Niihama, Japan. This plant has a capacity of 120 tons urea/day.

Another Chemico urea plant is being built at Niigata, Japan, for Nihon Gas Kagaku Kogyo K.K.; capacity, 90 tons urea/day. Completion is scheduled for early 1957.

Licensor—Chemical Construction Corp., 525 West 43rd st., New York 36, N.Y.

References—Some of the articles describing the Chemico urea synthesis process include:

(1) Anon., "Pushing for Protection," *Chemical Week*, Sept. 17, 1955, pp. 31-46.
(2) Cook, L. H., "New Process, Wide Uses Augur Growth for Urea," *Journal of Commerce*, Sept. 12, 1955.
(3) Cook, L. H., "Urea—The new Chemico Process is compared with six previous commercial processes," *Chemical Engineering Progress*, July, 1954, pp. 327-331.



Now...Thanks to Catforming...

HIGH OCTANES, HIGH YIELDS AT LOW COST!

Today, well into its third year of commercial operation, Atlantic's Catalytic Reforming Process is proving its ability to give superior results on a broad variety of feed stocks.

Catforming's simplicity brings savings through increased efficiency every step of the way—actually cutting out many intermediate steps.

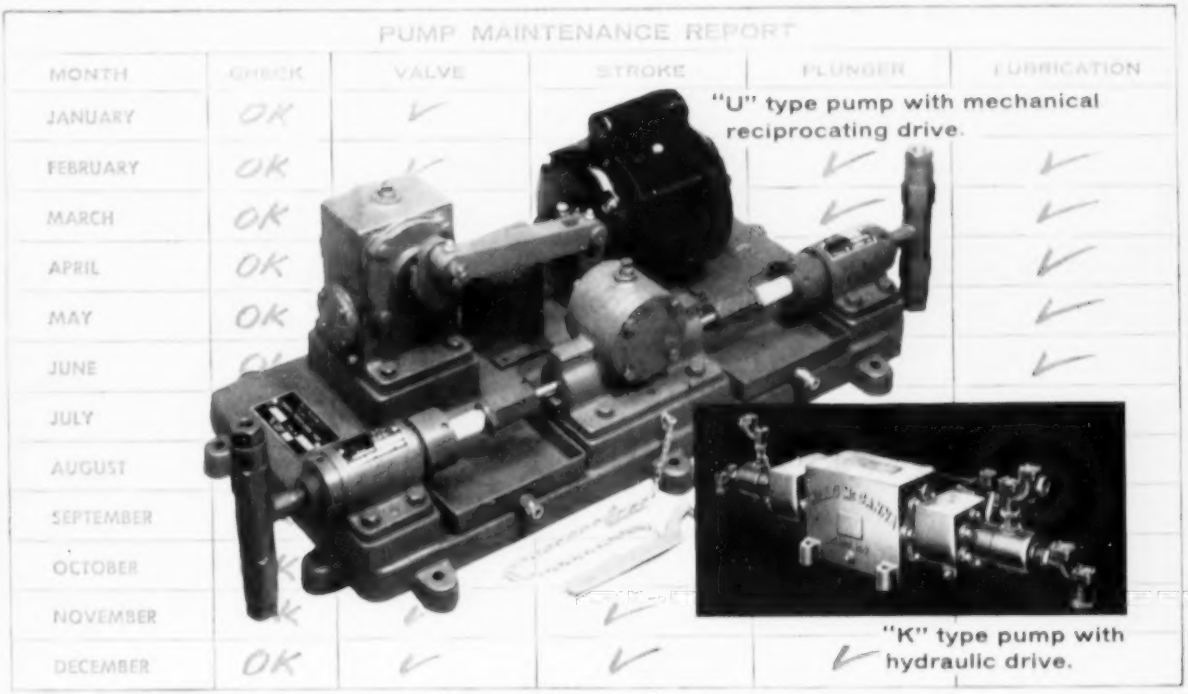
Regardless of the size of your operation or the nature of your charge stock, Catforming merits your attention. One reason Catforming has "proved out" commercially is Atlantic's broad experience in all phases of petroleum refining.

Phone or write for our detailed brochure, "CATFORMING." The Atlantic Refining Company, Research and Development Dept., P. O. Box 8138, Philadelphia 1, Pa.

it's the CATALYST that counts

ATLANTIC

Why the FIRST COST is the LAST COST with HILLS-McCANNA METERING PUMPS



HILLS-McCANNA dependability pays off in lower maintenance . . . longer life . . . greater accuracy . . . cost-saving versatility

Maintenance reports from the leaders in many different industries prove the low-cost operation of Hills-McCanna metering and proportioning pumps . . . tell why these pumps are specified for installations requiring the finest equipment. Part replacement is remarkably low because there are few points of wear. Routine maintenance is simple and economical thanks to special Hills-McCanna features, such as separate interchangeable check valves and easy, precise stroke adjustment (even while in operation when desired). Working parts are completely enclosed to keep them dirt-free. All U Type pump bodies are interchangeable in the housing for quick convertibility. Straight reciprocal drive eliminates bushing replacement. And, you'll find Hills-McCanna pumps mighty easy to install.

If you must continuously meter or proportion small volume flows with great accuracy, you'll want to consider the "U" type pump—available in 1, 2, 3 and 4 feed units. The "K" type pump —also available in 1, 2, 3 or 4 feed units—will meet your larger flow requirements.

Hills-McCanna can furnish a pump to meet *every* type of installation . . . with a wide choice of corrosion, wear and abrasion-resistant liquid ends . . . in capacities and pressures for every need.

Write for full facts now. You'll be dollars ahead tomorrow by investigating today!

A dependable NEW HEART to put NEW LIFE into your chemical metering system!

HILLS-McCANNA COMPANY

3025 N. Western Avenue, Chicago 18, Illinois

metering and proportioning pumps

also manufacturers of: FORCE FEED LUBRICATORS • DIAPHRAGM VALVES
MAGNESIUM ALLOY SAND CASTINGS

they never get tired!

• YARWAY Single-end Welding-type Gun-Pakt joint for 150 lbs. pressure.

• Some of the 189 YARWAY Gun-Pakt expansion joints installed at large oil refinery in Texas.

No fatigue **with 189 YARWAY GUN-PAKT EXPANSION JOINTS at this large Texas refinery**

THEY just work and work for years and never get tired. Yarway Gun-Pakt slip-type joints simply will not fail through fatigue. They will operate smoothly, as frequently as required, over long, full traverse up to 12" single type or 24" double type or short, partial traverse, day in and day out—with never any danger of metal fatigue or failure.

This is just one of the many big advantages found in Yarway Gun-Pakt expansion joints. Other outstanding Gun-Pakt features are:

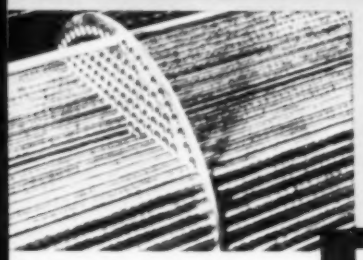
1. Can be serviced under *full* steam pressure day and night, thus avoiding costly and inconvenient shutdowns.
2. Fixed Gun-Pakt gland serves as "built in" external guide and permits less costly and rigid pipe guidance than required by many other types of joints.
3. Lower pressure load on end anchors because excessive strains are eliminated.

Used for many years with success in well-known refineries, industrial plants, utilities and institutions. When replacing present joints or planning new steam lines, it will pay you to look into the advantages of the Yarway Gun-Pakt expansion joint. Write for Yarway Bulletin EJ-1913.

YARNALL-WARING COMPANY
153 Mermaid Avenue, Phila. 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

gun-pakt expansion joints



STARTLING APPLICATIONS OF INCREASED HEAT TRANSFER

Using WOLVERINE TRUFIN* Type S/T

• CONDENSING STRAIGHT RUN GASOLINE

Located in the plant of a large Mid-West refinery this condenser, originally a plain tube unit, was retubed with Wolverine Trufin Type S/T. Here are the basic facts:

	PLAIN TUBE	TRUFIN TYPE S/T
TOTAL TUBE LENGTH	16,384	10,916
OUTSIDE SURFACE, SQ. FT.	3,215	5,420
METAL	14 BWG Admiralty	16 BWG (Cat. No. 195065) 90-10 Cu. Ni.

RESULTS:

The heat duty of the Trufin-tubed unit was 630,000 BTU's per hour greater than the plain tube condenser. Trufin's performance per foot of length, was 80% greater than the plain tube. In nearly two years of service, the Trufin unit has never required mechanical cleaning. Acidizing every four months has been adequate.

CONCLUSION: *Trufin is a Wise Buy!*

• CONDENSING ORGANIC CHEMICALS

The following data is based on the condensation of Freon-12 with water and was compiled after exhaustive tests under closely controlled conditions:

	PLAIN TUBE	TRUFIN TYPE S/T
SHELL SIZE O. D.	12¾"	12"
TUBE LENGTH	7'	7'
TUBE SPECIFICATIONS	⅝" O.D.—18 BWG 90-10 Cu. Ni.	⅝" O.D.—18 BWG (Cat. No. 195049) 90-10 Cu. Ni.
OUTSIDE SURFACE SQ. FT.	143.34	334.0

RESULTS:

On the basis of equivalent water velocity the prime surface unit extracted 411,000 BTU's per hour. The Trufin-tubed unit obtained 829,000 BTU's per hour.

CONCLUSION: *Trufin is a Wise Buy!*

• CONDENSING CRACKED GASOLINE

When tubed with plain tube, this superstructure mounted condenser, had to be mechanically cleaned every three months. In an effort to boost capacity, extend on-stream time, and eliminate the necessity of designing new exchangers, it was retubed with Wolverine Trufin Type S/T. Here are the vital statistics:

	PLAIN TUBE	TRUFIN TYPE S/T
NO. OF TUBES	500	500
OUTSIDE SURFACE AREA, SQ. FT.	1522	3280
METAL, ¾" O. D.	16 BWG Admiralty	16 BWG (Cat. No. 195065) Admiralty

RESULTS:

Heat duty jumped from 3,960,000 to 5,820,000 BTU's per hour with the Trufin bundle. Retubing permitted a 38% increase in throughput and a 47% increase in heat removal with a very large increase in length of run.

CONCLUSION: *Trufin is a Wise Buy!*

These are but three of many installations where Trufin is injecting greater performance into existing equipment. When retubing existing condensers or designing new ones, always specify Trufin Type S/T. For further information complete with case histories and design data, write for your copy of Wolverine's Trufin Opportunity Book. Do it today!
WOLVERINE TUBE, 1441 Central Avenue, Detroit 9, Michigan.

*REG. U.S. PAT. OFFICE

PLANTS IN DETROIT, MICH. AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPARTMENT, 11 EAST 44TH ST., N.Y. 16, N.Y.

DIVISIONS OF CALUMET & HECLA, INC.

CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER CO.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

STARTLING FACTS ABOUT HEAT TRANSFER

Where and how WOLVERINE TRUFIN* Type S/T Can Help You CUT COSTS, BOOST PERFORMANCE!

CHECK LIST

OF TRUFIN TYPE S/T ADVANTAGES THAT WILL HELP YOU SAVE

Trufin—with fins squeezed directly from the tube wall—has more than twice the heat transfer surface of plain tube. You need less tube because Trufin transfers more BTU's per foot of tube!

Fewer tubes mean smaller shells, headers, baffles . . . substantial savings in material requirements!

Less tubes mean less holes to drill—fewer rolling-in operations . . . a direct saving in time and labor costs!

Trufin requires much less over-all tube metal to transfer a given heat load. This means a real saving when expensive alloys are necessary . . . vital when alloys are in short supply!

Because Trufin installations require fewer tubes you can often design lighter units. Think of what this means when superstructure mounting is required!

Maintenance costs go down and stay down. Replacement tube costs are reduced, on-stream time increases because fewer tubes mean less cleaning time is necessary. Actual operating data shows that Trufin withstands fouling for longer periods of time than does prime surface tube. Operating time between change-overs is lengthened!

Trufin is completely interchangeable with prime surface tube. You follow standard retubing techniques!

Trufin withstands vibration, sudden temperature changes and pressure variations. Fin life is equal to that of the tube itself.

On the left, below, you'll find some basic reasons for the outstanding performance of Wolverine Trufin Type S/T—the integral finned condenser tube. You'll also find, below, a partial list of operations where Trufin can be used to good advantage. Study both lists carefully—check them against your own heat exchange operations—see for yourself just where and how Trufin can help you do a better job.

A FEW OF THE APPLICATIONS WHERE TRUFIN TYPE S/T CAN HELP YOU

- In Butane Condensers
- In Propane Condensers
- In Gasoline Condensers
- In Isopropyl Condensers
- In Condensing Butyl Heads
- In Gas Coolers
- In Condensing Organic Chemicals
- In Boiling Hydrocarbons
- In Heating or Cooling Gases
- In Heating or Cooling Oil or other liquid Hydrocarbons

As we have said—study these points. They can be your check list to greatly increased efficiency and economy in your heat exchange applications. Wolverine's new Process Flow Sheet Book contains many drawings of actual Trufin installations. Write today for your copy. WOLVERINE TUBE, 1441 Central Avenue, Detroit 9, Michigan.

Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.

*REG. U.S. PAT. OFFICE

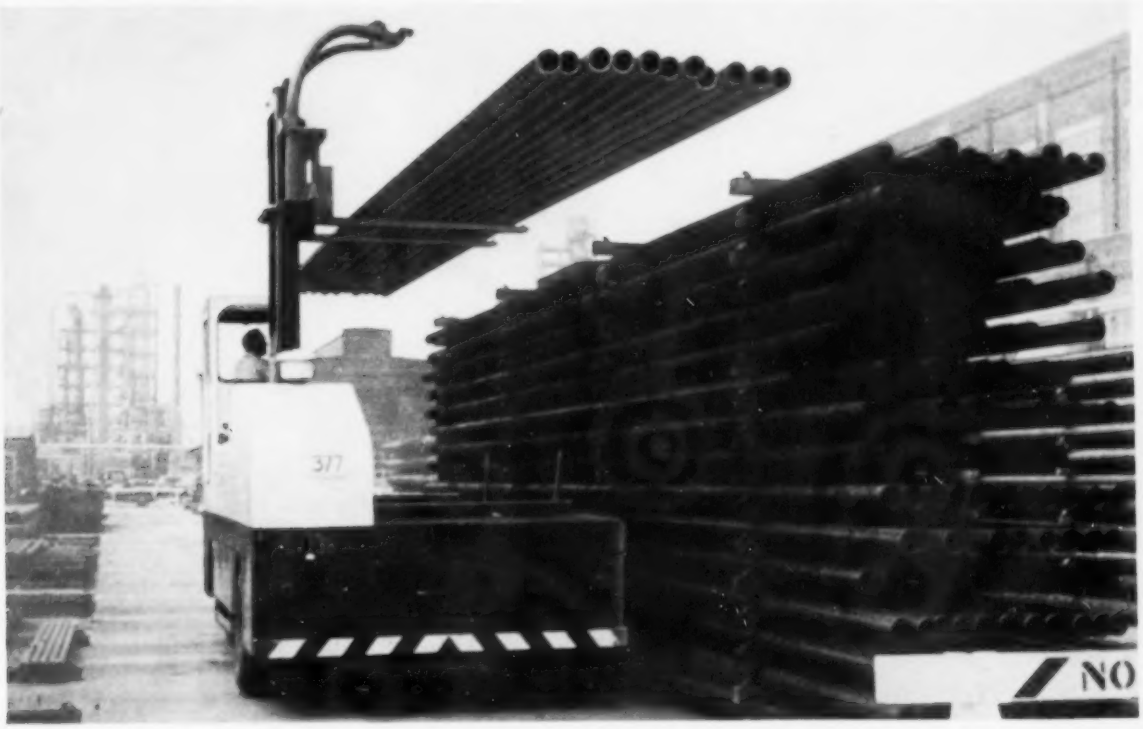
DIVISIONS OF CALUMET & HECLA, INC.
CALUMET DIVISION
WOLVERINE TUBE DIVISION
CANADA VULCANIZER & EQUIPMENT CO., LTD.
FOREST INDUSTRIES DIVISION
GOODMAN LUMBER CO.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

Manufacturers of Quality Controlled Tubing and Extruded Aluminum Shapes

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES.
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK



Not a "Side-Winder"— But a Side-Loader

MATERIALS handling at a refinery involves a wide variety of equipment, both handled and handling. Often, for instance, a combination of a straddle carrier plus a mobile crane is needed to handle and store one piece of heavy equipment, such as a tube bundle. Or the unloading and transporting of pipe requires manual loading onto a truck that can carry it parallel to the direction of travel.

Increasing use is being made today of a side-loading "fork-truck" (made by Baker-Rauling Co., Cleveland) that can combine two functions in one piece of equipment. As used at the Bayway refinery of Esso Standard Oil Co., this new equipment can handle a variety of jobs by itself, including stacking and transporting pipe, lumber, and structural steel. Plans call for its use in the refinery warehouse also.

Unlike the usual fork-lift truck, the side-loader's forks operate at the side, perpendicular to the direction of travel. Pick up or delivery of loads at any level within the truck's range to a height of 12 ft is possible. Once the load is picked up, the entire fork mast is hydraulically retracted across the bed of the truck. Then the load is lowered to the truck deck for transportation.

The truck has no counterweights and is braced against an unbalanced weight during loading by retractable hydraulic jacks. All lifting and driving controls are in the operator's cab. Running on truck tires and springs, it has conventional headlights and power steering. The top road speed is 30 mph when fully loaded.

It's Coffee-Time, Boys

FACILITIES for preparing hot lunches or coffee are an important part of the layout for a natural gasoline plant—or any plant for that matter. But when the desired location is near gasoline loading racks, some ingenuity is needed to install the normal hot plate.

A satisfactory solution was developed at the Carsgray natural gasoline plant, of Dorchester Corp., located near White Deer, Texas. Because open flame or electric hot plates could not be allowed in the locker room, a steam hot plate was installed as an integral part of the steam radiator. A bypass steam line runs directly into a tightly welded steam box and heats its wide, flat top to cooking temperature.

Why gamble with SAFETY by selecting fittings like this?

or this?

or this?

when you can be SAFETY sure with

Swagelok® FITTINGS

GET ALL THE FACTS: Write for the Swagelok catalog. Address Dept. D7

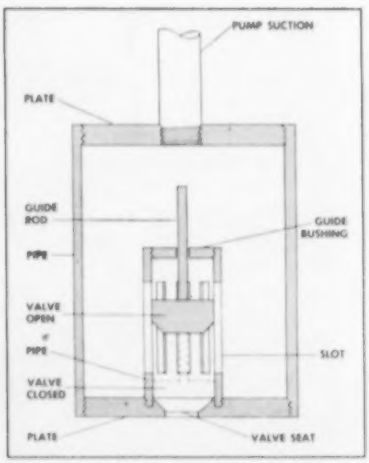
CRAWFORD FITTING CO.
884 EAST 140th STREET
CLEVELAND 10, OHIO

Galvanized Bikes Chop Paint Costs

BICYCLE upkeep is not the biggest headache of a refinery maintenance crew. But it can be a problem. When over 500 bicycles are used, their annual dismantling and painting can be a costly and time-consuming chore. Humble Oil and Refining Co. in Houston, Texas, has licked one big phase of the problem.

Because dampness was corroding Humble's fleet of messenger bicycles, the company developed a yearly dismantling and repainting program. A search for a better corrosion control method showed that it was cheaper to galvanize the bicycles than to repaint them after dismantling. Now all bicycles have been galvanized and painting is a thing of the past. Even Humble's new motor scooters were ordered with all sheet-metal parts made of galvanized steel.

Valve Substitute Saves the Day



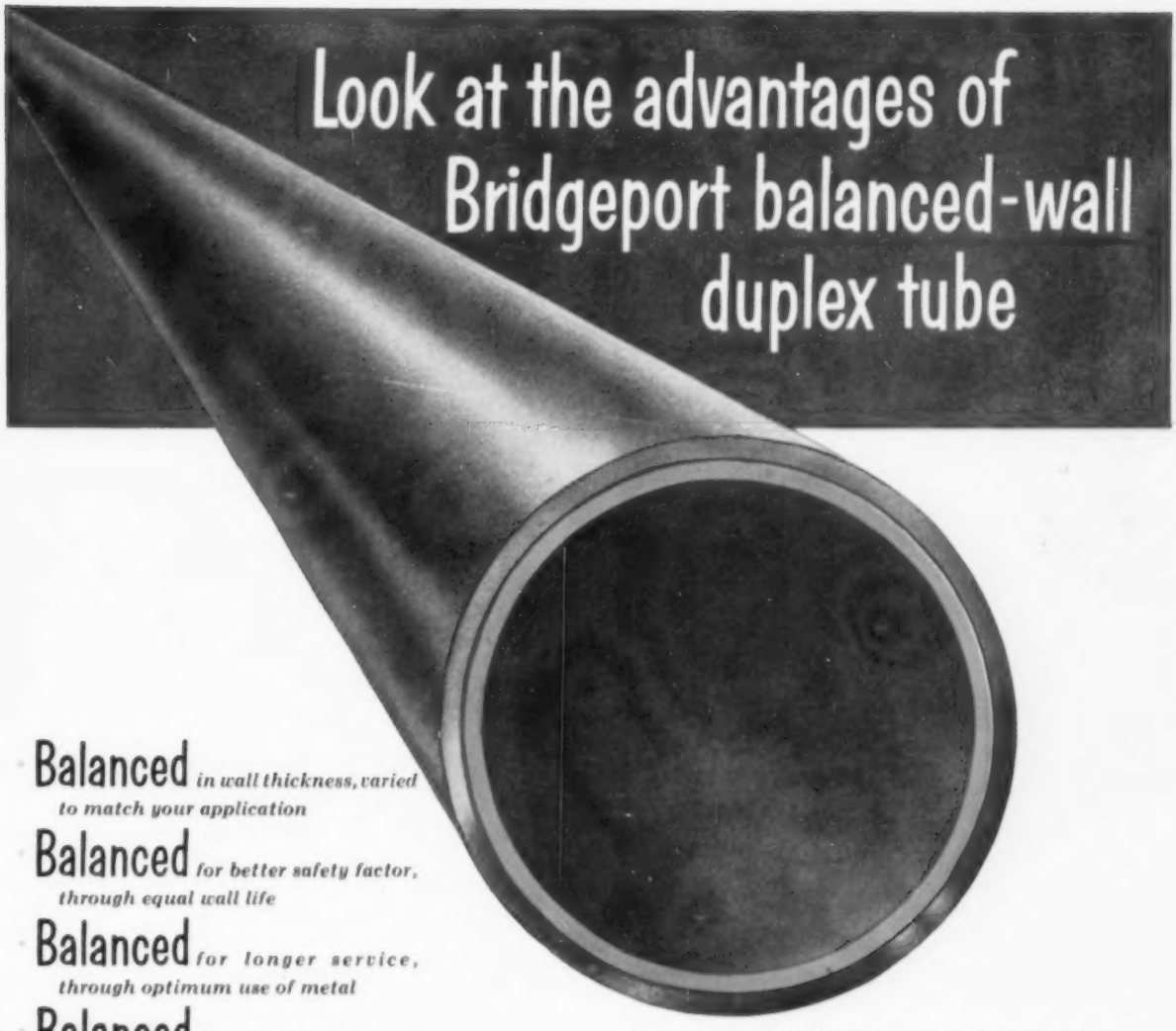
AT Phillips Petroleum Co.'s Kansas City refinery they had a problem. Delivery of a special alloy valve was held up, and an immediate replacement was needed. The centrifugal sump pump in copper chloride service operated only briefly, several times a week. But it was important to prevent the pump from losing its prime between each operation, because priming took 30 minutes each time.

A special all-Bakelite valve was placed into immediate service. It was designed by a pipefitter and fabricated in the refinery machinery shop. The valve was not only cheaper than the special alloy valve but has performed satisfactorily in this corrosive service.

As the copper chloride solution is

 (To obtain more data on advertised products see page 174)

Look at the advantages of Bridgeport balanced-wall duplex tube



Balanced *in wall thickness, varied to match your application*

Balanced *for better safety factor, through equal wall life*

Balanced *for longer service, through optimum use of metal*

Balanced *in metal specification to resist different types of corrosion, inside and out*

Bridgeport Duplex Tubes are available in many combinations of copper-base alloys with steel, aluminum and other metals. Lifetime Costs Are Lowest With Bridgeport Duplex Tubing.

Before specifying any heat-exchanger tubes, consider these facts: The job of each Bridgeport Duplex Tube is analyzed and gauges are calculated so that both inner and outer tubes will attain the same long life. The wall thickness of the component tubes in Duplex is varied to meet your specific application needs as influenced by temperature, pressure, corrosion rate on the inside and outside. You are assured a *balanced-wall* Duplex Tube, with improved safety factor, which makes practical use of every ounce of metal.

Another important benefit is the superior heat-transfer properties of Bridgeport Duplex Tube, achieved by a closer, cleaner bond on the interfaces. And, of course, by resisting different types of corrosion inside and out, they eliminate or reduce the need for frequent retubing and shutdowns, and reduce maintenance costs substantially.

Add up all these advantages, and you see that Bridgeport Duplex Tubes give consistently superior performance *and* lasting economy over a period of time. Remember, it's lifetime costs that count and Bridgeport Balanced-Wall Duplex Tubes assure lowest lifetime costs. Our Technical Service Department will be glad to recommend Duplex Tubes to match your individual service requirements.

Call your local Bridgeport Sales Office for complete information. Ask for Bridgeport's Duplex Tube Technical Bulletin.

BRASS Bridgeport CO.

BRIDGEPORT BRASS

Offices in Principal Cities · Conveniently Located Warehouses

Bridgeport Brass Company, Bridgeport 2, Connecticut • In Canada: Noranda Copper and Brass Limited, Montreal

CAPACITY for QUALITY

IN TODAY'S GREASE MANUFACTURE

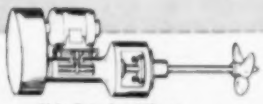
PATTERSON
GREASE MIXERS

Patterson Grease Kettles and Mixers lead the field in heavy lubricant production. Equipped with heavy duty, double motion drive and efficient clean-scraping stirrers. Let us explain the many advantages to you!

Richard L. Cameron
President

Top Entering Mixers

Grease Kettles


Side Entering Mixers

Give outstanding performance in blending, sweetening and ethylizing of gasoline, blending of oils, etc.

The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, ATLANTA, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE

The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

pulled into the suction side of the pump, the Bakelite valve lifts, permitting the liquid from the sump to be pumped out. When the pump stops and the fluid starts to return to the sump it carries the valve with it, sealing and priming the pump suction for the next startup.

This award-winning suggestion was submitted by D.B. Price of Phillips Petroleum Co.'s Kansas City refinery.

Tube Inspection Tool Doubles as "Chemist"

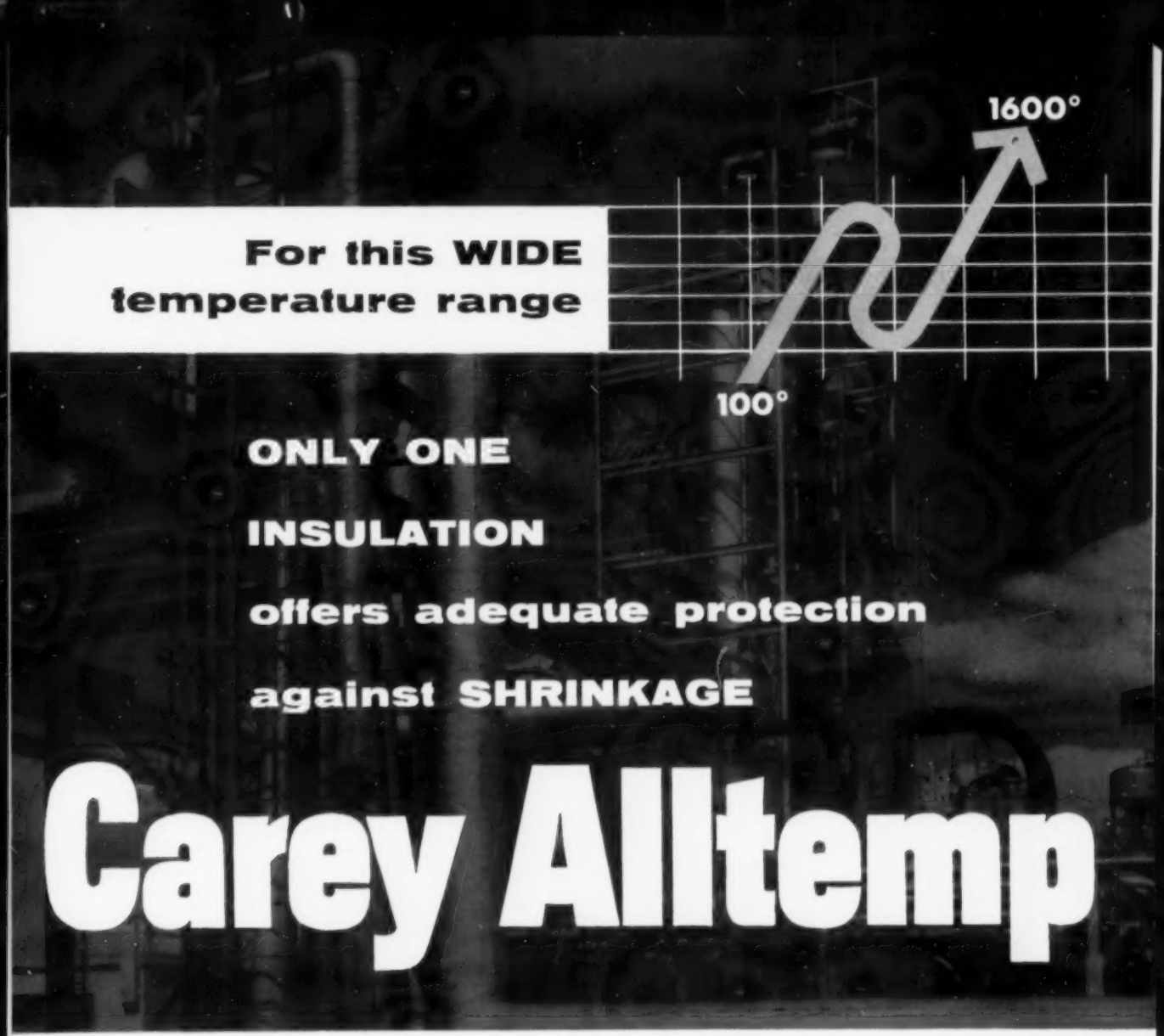
THE Probolog is an electronic instrument developed and patented by Shell Development Co. Its primary purpose is to indicate defects in nonferrous heat exchanger tubing, using a probe and an amplifying recorder. But at Shell Oil Co.'s Wood River refinery in Illinois, the same instrument is used to differentiate between chrome alloys and carbon steel tubes.

Using the Probolog this way eliminates many possible identification errors during acid tests, for distinguishing carbon steel and intermediate chrome alloy. In the acid test, nitric acid is dropped on the unknown specimen. If it is carbon steel the acid will react, but if the material is 5 Cr steel it will not. However, false indications may be given by the presence of oil on the surface tested, or by a thin blue surface oxide caused by grinding.

Identification of tubing materials by the Probolog depends on the sensitivity of the instrument to the magnetic permeability of the tubing material. The variation in permeability is shown in the recorded pattern on the amplifying recorder. For steel the pattern is irregular; for chrome steel the pattern is almost a straight line. Pattern irregularities caused by wall roughness in the chrome steel tube do not interfere with results because they are of smaller magnitude than those inherent in carbon steel.

Because of the success of this system of combining the Probolog inspection with the acid check on questionable tubes, Shell at Wood River uses the procedure in verifying tubing materials in new chrome alloy steel tube bundles.

Although the Probolog was developed and patented by Shell Development Co., the instrument is made by others. The probes are made by Electro Engineering Works in Oakland, Calif., and the amplifying recorder, by the Foxboro Co. of Foxboro, Mass.



For this WIDE temperature range

ONLY ONE INSULATION offers adequate protection against SHRINKAGE

Carey Alltemp

■ Super-efficient ALLTEMP is a *universal* pipe and block insulation, offering extremely low shrinkage characteristics. It is easy to work and shape to fit any installation. ALLTEMP also gives you high moisture resistance, high thermal efficiency, unmatched structural strength—all the properties that mean low, low maintenance. Here—*in one formulation*—is the performance you want for *all* temperatures up to 1600° F. For cost-saving facts and the Carey ALLTEMP Specification Folder, mail coupon below.

Carey

industrial insulation

THE PHILIP CAREY MFG. COMPANY

Better Products for Industry Since 1873

Lockland, Cincinnati 15, Ohio

In Canada: The Philip Carey Co., Ltd., Montreal 3, P. Q.

Carey-approved contract units in major trading areas. Consult your nearest Carey District Office or your telephone directory.

THE PHILIP CAREY MFG. COMPANY,
Lockland, Cincinnati 15, Ohio, Dept. PP-5

Send ALLTEMP Folder of specifications and installation details.

☐ Have your Industrial Sales Engineer call.

NAME .....

COMPANY .....

ADDRESS .....

CITY ..... ZONE ..... STATE .....

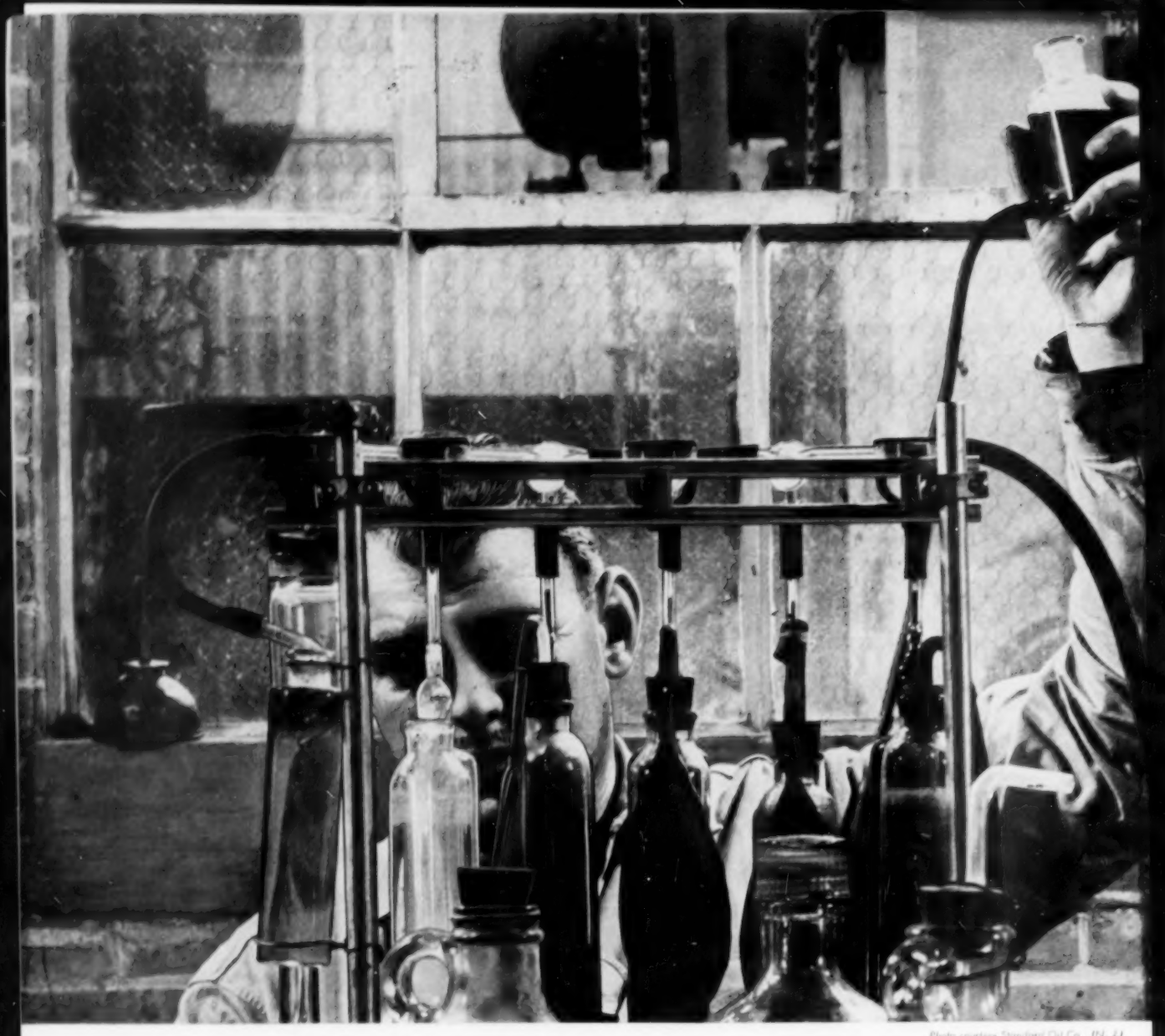


Photo courtesy Standard Oil Co., IN. J.

boost average ratings as much as 2 octane numbers

with the LJUNGSTROM® AIR PREHEATER

With waste heat recovered and returned to the furnace in combustion air, the most modern heat-transfer systems can be operated at peak efficiency.

That's why you boost product quality with the Ljungstrom Air Preheater. Its heat-recovery efficiency makes possible advanced furnace designs that assure remarkably close control of processing. And finer control means a more uniform product . . . with average ratings as much as 2 octane numbers higher. One still's added income just from higher product quality is $58,000 annually.

How fast is "WRITE-OFF"?

In earnings from higher octane ratings, many refiners write off the cost of the Ljungstrom installation in less than two years. This time is cut to nine months and even less, when the other Ljungstrom advantages are taken into account – saves up to 20% in fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat recovery benefits obtainable in fuel burning equipment – call or write The Air Preheater Corporation.

Wherever You Burn Fuel, You Need Ljungstrom

The Ljundstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Hydrogen Peroxide

Hydrogen peroxide, a chemical long known in households as an antiseptic and hair bleach, has today taken its place in the ranks of petrochemicals. Household use, of course, is only a very minor application of this versatile oxidizing agent, which is a colorless liquid, heavier than water and soluble in water and alcohol. Its name is pronounced "**high**-dro-jen per-**ock**-side," and has the formula H_2O_2—differing from water (H_2O) by possessing an extra (all important) oxygen radical which it then gives up in serving bleaching, oxidizing, antiseptic, and similar functions.

In the past, hydrogen peroxide has been chiefly produced by the electrolytic oxidation of sulfuric acid, followed by hydrolysis (reaction with water) and concentration. Other processes are in use, but chief interest at present is centered on a method which will this year be used commercially for the first time—the liquid-phase oxidation of isopropyl alcohol to yield acetone and hydrogen peroxide. Isopropyl alcohol, of course, was one of the first chemicals to be produced from petroleum materials—in this case, propylene from cracked refinery gases.

The chief reason for the expanding production and consumption of hydrogen peroxide is its recent availability in high-purity, highly concentrated form. This permits its use in a wide variety of organic syntheses, either directly or in the production of reactive intermediates. The compounds which result from some of these reactions—epoxy compounds and glycols—are used in the manufacture or compounding of resins, lubricants and lubricant additives, surface-active agents, insecticides, etc. The output of the new plant which will produce hydrogen peroxide from isopropyl alcohol is slated for use in the production of synthetic glycerol from acrolein. Military uses, including rocket fuels, also add materially to such civilian uses as textile and pulp-and-paper bleaching.

Continued expansion of the markets for hydrogen peroxide is definitely expected. Hydrogen peroxide may soon be better known as a rocket fuel than as a household chemical.

Vinyl Propionate

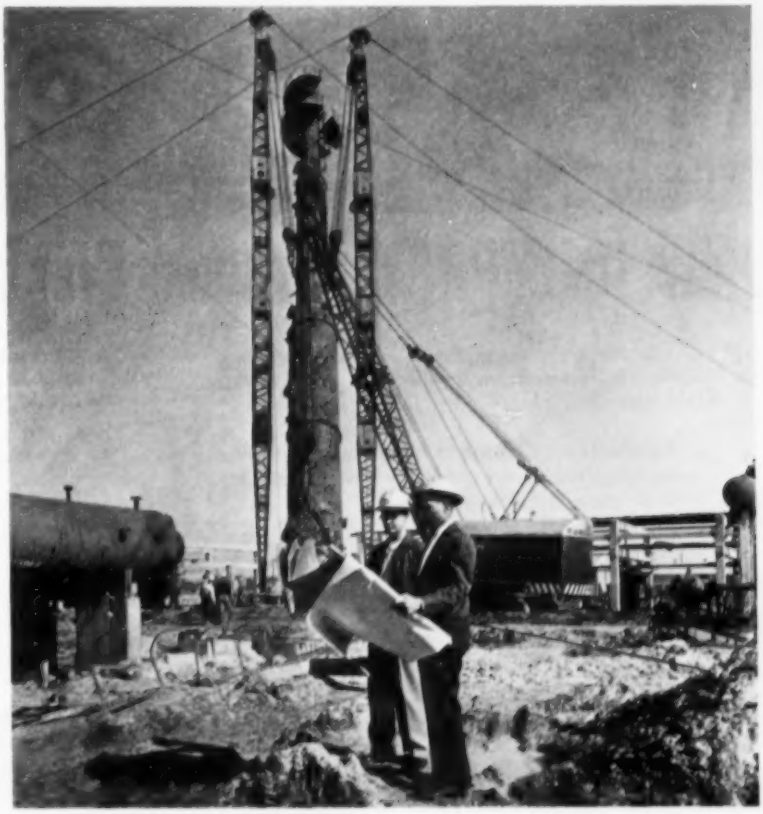
Vinyl propionate, pronounced "**vi**-nil **pro**-pih-uh-nate," is a clear, colorless, volatile liquid with the formula $CH_2{=}CH\text{-}O\text{-}C(O)\text{-}CH_2\text{-}CH_3$. A new petrochemical, commercially, this material now joins the ranks of other vinyl monomers—substances which are basic building blocks for plastics, fibers, coating materials, etc.

Similar to these other vinyl monomers, vinyl propionate can be reacted with itself to form long-chain, high-molecular-weight polymers. When reacted with vinyl acetate, vinyl chloride, acrylic esters, acrylic acid, methacrylic esters, maleic esters, maleic anhydride, butadiene, styrene, acrylonitrile, or acrylamide, co-polymers with special properties are formed. Vinyl propionate imparts a relatively high degree of flexibility, water-spotting resistance, and adhesiveness to the final product.

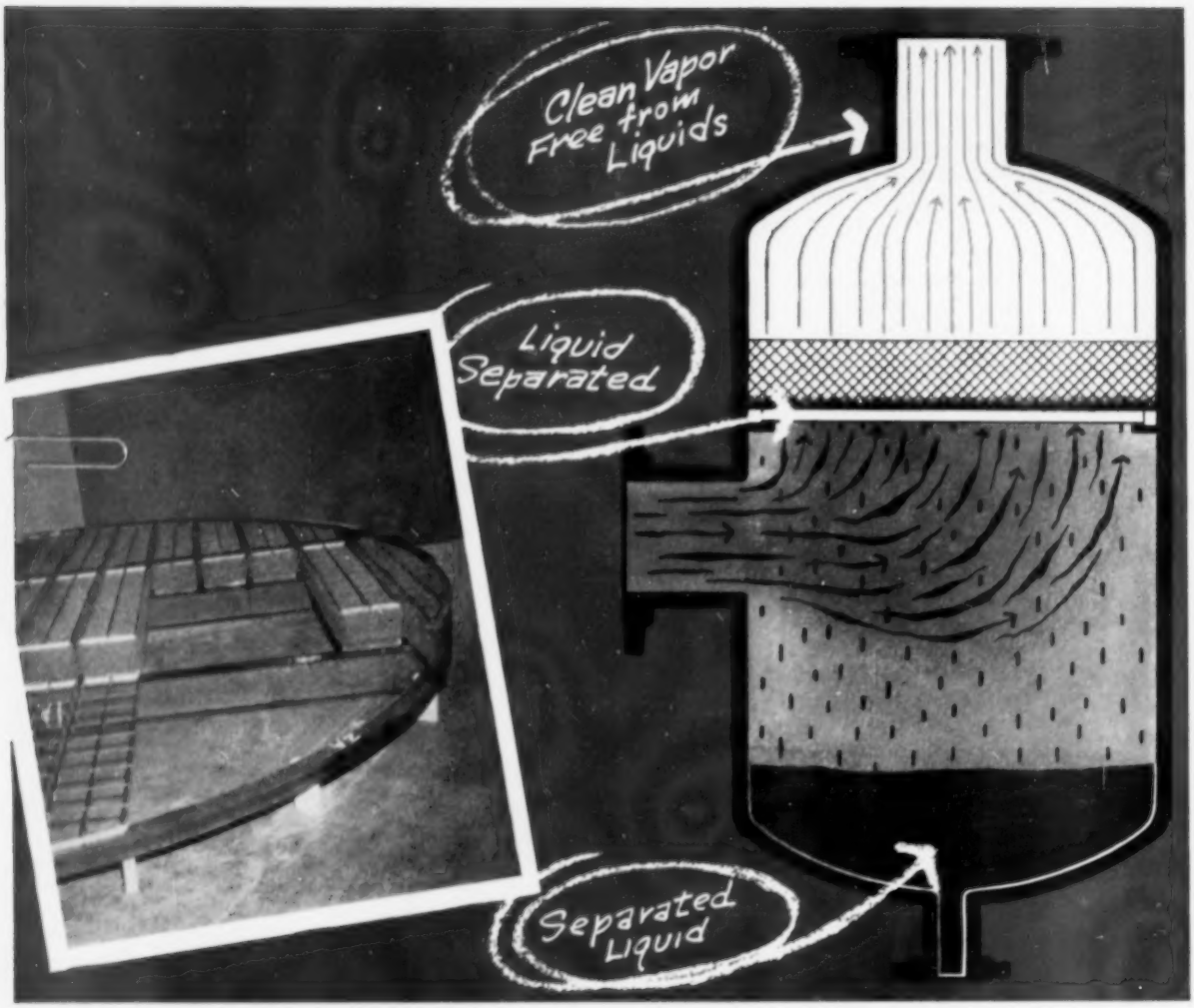
End-use products employing vinyl propionate polymers find application in adhesives, synthetic rubbers, chewing-gum resins, finishes for leather, paint emulsions, and coatings in general. Present production is based on intermediates prepared by the air oxidation of natural gases, although intermediates can also be produced from acetylene (itself a petrochemical).

Vinyl propionate is another one of those petrochemicals, now coming on the market, which yield new or improved articles of commerce. Its future will be watched with interest by many.

NEWS in VIEWS



FRACTIONATING TOWER is going up on 1,100 acre site of American Oil Co.'s 35,000 b/d refinery at Yorktown, Va. Tower is part of combination crude distillation and cat cracking unit. Target is full operation by early 1957



How to IMPROVE Process Vessel PERFORMANCE

By effecting clean separation of liquid from vapor Yorkmesh Demisters improve process vessel performance.

In **distillation equipment** liquid entrainment is controlled, giving better quality overhead products even at increased thruput rates.

In refinery **vacuum towers,** higher quality gas oil means higher conversion rates to gasoline in the cat cracker.

In **absorbers,** loss of absorbing liquid is prevented.

In **separator vessels** and **knock-out drums** greater liquid recovery results.

In compressor **suction drums,** complete liquid separation decreases compressor maintenance.

In **evaporators,** by controlling liquid carry-over product loss is avoided, and high purity condensate is suitable for boiler feedwater or process use.

In **steam drums** the result is clean, dry steam.

In **vent stacks** Yorkmesh Demisters contribute to the solution of air pollution problems.

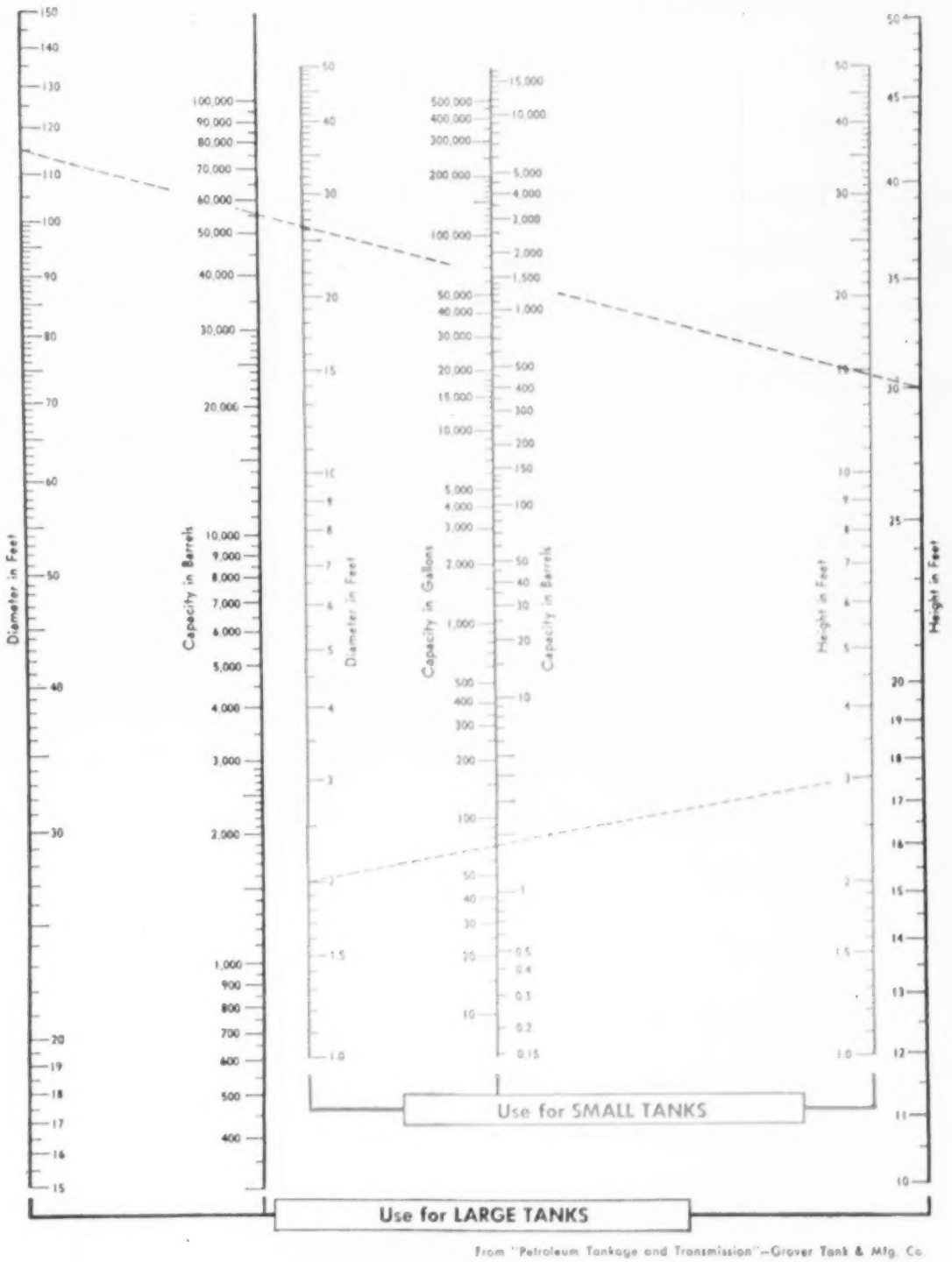
Write for Bulletin 17 and a complete list of the many case histories available from our technical library.

YORK

OTTO H. YORK COMPANY, INC.
6 Central Avenue, West Orange, N. J.

Specialists in **FLUIDS SEPARATION** / **ENGINEERS and MANUFACTURERS**

TANK CAPACITY DIAGRAM FOR APPROXIMATE VALUES



From "Petroleum Tankage and Transmission"—Grover Tank & Mfg. Co.

For Tables on Typical Tanks, Turn the Page . . .

TANK CAPACITIES — Cylindrical, vertical

DIMENSIONS D	DIMENSIONS H	CAPACITY BBL	CAPACITY 1000 GAL
15	12	378	16
	18	567	24
	24	756	32
	30	945	40
	36	1,134	48
20	12	672	28
	18	1,008	42
	24	1,344	56
	30	1,680	71
	36	2,016	85
	42	2,352	99
25	12	1,050	44
	18	1,575	66
	24	2,100	88
	30	2,625	110
	36	3,150	132
	42	3,675	154
	48	4,200	176
30	12	1,512	64
	18	2,268	95
	24	3,024	127
	30	3,780	159
	36	4,536	191
	42	5,292	222
	48	6,048	254
35	12	2,058	86
	18	3,087	130
	24	4,116	173
	30	5,145	216
	36	6,174	259
	42	7,203	303
	48	8,232	346
40	12	2,688	113
	18	4,032	169
	24	5,376	226
	30	6,720	282
	36	8,064	339
	42	9,408	395
	48	10,752	452
45	12	3,402	143
	18	5,103	214
	24	6,804	286
	30	8,505	357
	36	10,206	429
	42	11,907	500
	48	13,608	572
50	12	4,200	176
	18	6,300	265
	24	8,400	353
	30	10,500	441
	36	12,600	529
	42	14,700	617
	48	16,800	706
60	12	6,048	254
	18	9,072	381
	24	12,096	508
	30	15,120	635
	36	18,144	762
	42	21,168	889
	48	24,192	1,016
70	12	8,232	346
	18	12,348	519
	24	16,464	691
	30	20,580	864
	36	24,696	1,037
	42	28,812	1,210
	48	32,926	1,382
80	12	10,752	452
	18	16,128	677
	24	21,504	903
	30	26,880	1,129
	36	32,256	1,355
	42	37,632	1,581
	48	43,008	1,806
90	12	13,608	572
	18	20,412	857
	24	27,216	1,143
	30	34,020	1,428
	36	40,824	1,715
	42	47,628	2,000
	48	54,432	2,286
100	18	25,200	1,058
	24	33,600	1,411
	30	42,000	1,764
	36	50,400	2,117
	42	58,800	2,470
	48	67,200	2,822
110	18	30,492	1,281
	24	40,656	1,708
	30	50,820	2,134
	36	60,894	2,561
	42	71,148	2,988
	48	81,312	3,415
120	18	36,288	1,524
	24	48,384	2,032
	30	60,480	2,540
	36	72,576	3,048
	42	84,672	3,556
	48	96,768	4,064
130	18	42,588	1,789
	24	56,784	2,385
	30	70,980	2,981
	36	85,176	3,577
	42	99,372	4,174
	48	113,568	4,770
140	18	49,392	2,074
	24	65,856	2,766
	30	82,320	3,457
	36	98,784	4,149
	42	115,248	4,840
	48	131,712	5,532
150	24	75,600	3,175
	30	94,500	3,969
	36	113,400	4,763
	42	132,300	5,557
	48	151,200	6,350
	54	170,100	7,144
160	30	107,520	4,516
	36	129,024	5,419
	42	150,528	6,322
	48	172,032	7,225
	54	193,536	8,129
180	30	139,080	5,841
	36	166,896	7,010
	42	194,712	8,178
	48	222,528	9,346
	54	250,344	10,514
200	30	168,000	7,056
	36	201,600	8,467
	42	235,200	9,878
	48	268,800	11,290
	54	302,400	12,701

Capacity (barrels)=0.14 D^2H 1 barrel=42 gallons

Pick YOUR Number –Win New Friends For Your Business!

Here is a simple way to make new friends for your business – and at the same time perform a real service for your industry.

You may ask "does my industry need help?" The answer is *yes*. For today it is urgent that the public appreciate more thoroughly the job oil men do. People must continue to feel the oil industry can best serve *them* by remaining privately managed, fully competitive, and free from excessive governmental control.

You can help in this vital public information program by joining your local Oil Industry Information Committee – made up of oil men from your community. Right now, 33,299 oil men like yourself are active. Aided by the OIIC District Office, your group can provide films, speakers and demonstrations for civic, social and church needs – in addition to classroom materials for high schools.

Joining in this effort will mean real help for your industry. But *you* will also profit. You'll enjoy the great personal pleasure of working with other members of your community. It will mean winning many new friends for yourself – and for your business as well.

So pick *your* number on the map above – and get in touch with the OIIC District Office in your area today! Why not do it *now* while you have the address handy.

AMERICAN PETROLEUM INSTITUTE

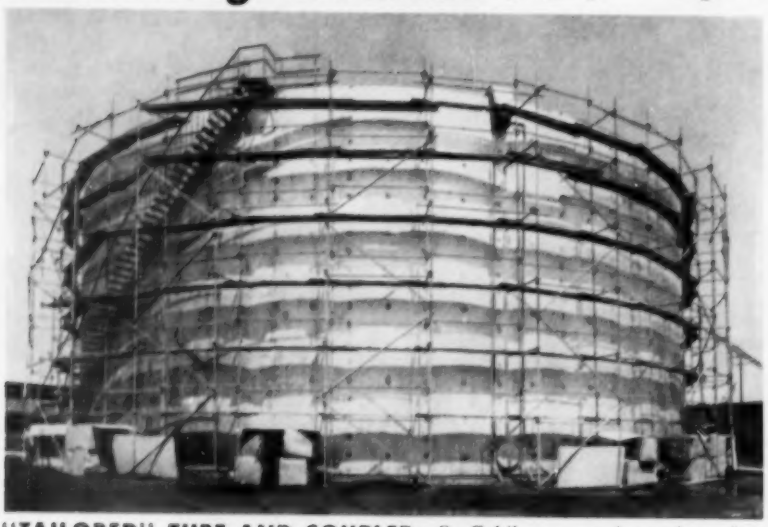
50 West 50th Street, New York 20, New York

Oil Industry Information Committee District Offices

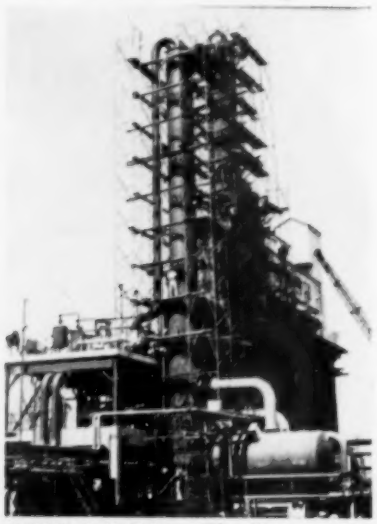
1. *Rhode Island, Conn., Mass., Vt., New Hampshire, Maine*
   419 Boylston Street
   Boston 16, Massachusetts
2. *New York, New Jersey*
   1270 Sixth Avenue, Room 1913
   New York 20, New York
3. *Del., Pa., Md., Va., W. Va., Dist. of Columbia*
   1322 Broad-Locust Building
   Philadelphia 2, Pennsylvania
4. *N. Carolina, S. Carolina, Georgia, Florida*
   26 Cain Street, N.W.
   Atlanta 3, Georgia
5. *Kentucky, Ohio, Tennessee*
   506 Schmidt Building
   Cincinnati 2, Ohio
6. *Illinois, Wisconsin, Michigan, Indiana*
   8 South Michigan Avenue
   Chicago, Illinois
7. *Missouri, Iowa, Nebraska*
   1459 Dierks Building
   Kansas City 6, Missouri
8. *Minnesota, N. Dakota, S. Dakota*
   1110 Rand Tower
   Minneapolis 2, Minnesota
9. *Texas, New Mexico*
   318 North St. Paul Street
   Dallas, Texas
10. *Arkansas, Louisiana*
    Whitney National Bank Building
    New Orleans, Louisiana
11. *Alabama, Mississippi*
    670 Milner Building
    Jackson, Mississippi
12. *Kansas, Oklahoma*
    308 Oil Capital Building
    Tulsa 3, Oklahoma
13. *Colo., Montana, Wyoming, Idaho, Utah*
    526 Farmers Union Building
    Denver, Colorado
14. *Wash., Oregon, Calif., Nevada, Arizona*
    510 W. 6th Street
    Los Angeles 14, California

Advertisement

Scaffolding Methods . . . by Patent Scaffolding Co.

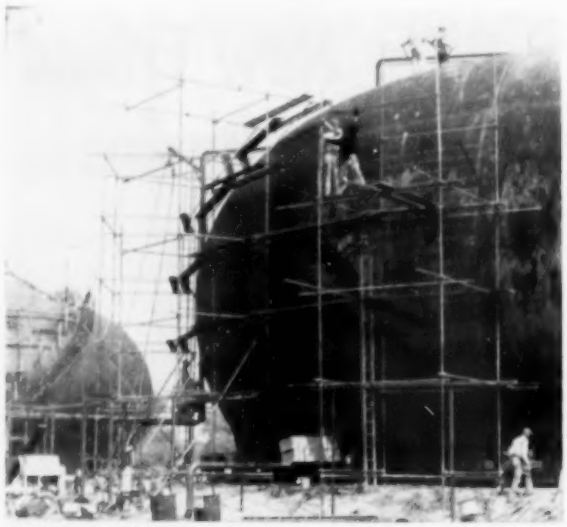


"TAILORED" TUBE AND COUPLER—Scaffolding curved or irregular shapes at multi-levels (such as on this Richfield Oil Co. storage tank at Harbor Island, Seattle) to extreme heights or on uneven terrain is fast and easy with "TubeLox"® Scaffolding. This all-purpose equipment for construction and maintenance uses only four basic parts. Interlocking 2″ or 2½″ o.d. steel tubes, 6, 8, 10, 13, 16 and 20-ft. long are joined by standard or adjustable steel couplers. "TubeLox" can be "tailored" to practically any conditions and gives workers access to all surfaces. Strong and fireproof, "TubeLox" is both versatile and economical for all petroleum industry jobs. Write for application details in Bulletin PTS-18.



TOWER WORK—The Koppers Co. uses "Trouble-Saver"® Scaffolding prefab sectional steel frames, 6′6″ high, to quickly erect scaffolding for maintenance work on stacks at Port Acres, Texas refinery. These fireproof units require no tools, go up faster than wood scaffolds. "Trouble-Saver" end frames are 5-ft. wide and vary in height from 3-ft. to 10-ft., 1-in. Write for Bulletin PSS-34.

HANGING HELPER—For decorating, painting and similar light-duty maintenance jobs, the "Gold Medal"® Midget Safety Swinging Scaffold offers time-saving at low cost. It is suspended quickly from "S" or "L" hooks on ¼″ steel wire cable; raised and lowered by light, compact Midget Machine. Write for Bulletin J-9(M).



SHAPED TO FIT—Insulation work on tanks at Gulf Refining Co., Toledo, Ohio, is done from cantilevered "TubeLox" tube-and-coupler Scaffolding which conforms easily to curved or irregular surfaces and odd shapes. Ideal for scaffolding on storage tanks, blowdown or alkylation plant stacks, vacuum units and exchangers.

To help you with your scaffolding methods, PS offers a complete nation-wide engineering service available to you locally. See the Yellow Pages in your 'phone directory for the nearest Patent Scaffolding office or representative that **sells** and **rents** "Gold Medal" Scaffolds.

FOR GREATER SAFETY...EFFICIENCY...ECONOMY

THE PATENT SCAFFOLDING CO., Inc.

38-21 12th Street Dept. PP Long Island City 1, N. Y.
West Coast: 6931 Stanford Ave., Los Angeles 1, Calif.
Branches in all principal cities
In Canada: 355 Dufferin St., Toronto

ASSIGNMENT: GUIDED MISSILES—Eger V. Murphree, president of Esso Research and Engineering Co., now special assistant to the Secretary of Defense for at least a year, will direct and coordinate the government's research and development program in guided missiles.

T. A. Helling, president and general manager of El Dorado Refining Co., has been elected chairman of the board. **George J. Peterschmidt** succeeds him as president, and **Sam L. Robertson** has taken over Peterschmidt's post of executive vice-president and treasurer.

A. P. Frame, in charge of research and petrochemical activities of Cities Service Co. subsidiaries, has been made a vice-president of the parent firm. Frame has been a director for the past year, and his newest appointment is part of the company's announced expansion of its activities.

Other directors of the parent company who have been appointed vice-presidents are **George H. Shaw, George H. Hill, Jr.,** and **Charles S. Mitchell.**

At the same time, **Chester E. Weger,** vice-president and director of Cities Service Refining Co., has been elected to the board of directors of the parent company.

F. Cushing Smith has been assigned to the new position of assistant to the president of Standard Oil Co. (Ind.). He was formerly assistant superintendent of the Whiting refinery.

O. J. Glasman, who has been administrative assistant to the president since 1955, has been promoted to assistant manager of the organization department.

Dr. W. H. Bahlke has retired from the post of research coordinator in the company. He began with Standard as a chemist in 1921.

Otto N. Miller has been appointed chairman of the Western Oil and Gas Association's air pollution control committee. He is vice-president in manufacturing of Standard Oil Co. of California. Miller succeeds **P. S. Magruder,** executive vice-president of General Petroleum Corp., as committee chairman.

W. H. Vaughan, manager of the gas utilization department of Tide Water Associated Oil Co., has been given this year's Hanlon Award for service to the natural gasoline industry. He is cited for experimentation and original thinking that made him "one of the earliest pioneers in finding a practical solution to the gas cycling problem." Vaughan's work led to his design and construction of the first cycling plant licensed by the Texas Railroad Commission.

He was with Gulf Oil Co. shortly after the first World War and until 1933, when he resigned as superintendent of natural gasoline operations to do private research. In 1935 he joined Tide Water as supervisor of operations in gas-condensate fields.

Vaughan is the 20th Hanlon Award winner. The award was conferred at the recent annual meeting of the Natural Gasoline Association of America in Ft. Worth.

Dr. Jacob E. Jansen has been appointed director of organic chemicals research at the B. F. Goodrich Co.'s research center in Brecksville, Ohio. Jansen was graduated from Carleton College with a B.S. and earned his Ph.D. in organic chemistry at Harvard University. He joined Goodrich as a research chemist in 1938, held a number of key positions on the research staff and eventually became manager of polymer chemical research.

Dr. Jansen

R. D. Glenn has been appointed assistant works manager of Carbide and Carbon Chemicals Co.

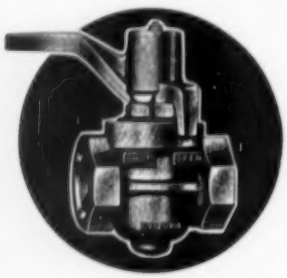
F. H. Belden has been named general superintendent and **R. C. Hieronymus** a superintendent at South Charleston. **H. A. Stuewe** has been made assistant superintendent of the plant at Texas City, Texas.

Glenn began with the company in 1934 after receiving an M.S. in chemical engineering from M.I.T. He was named superintendent at South Charleston in 1953 and general superintendent a year later.

HERE'S HOW
DEZURIK VALVES ARE DIFFERENT!

It takes only a short, easy QUARTER-TURN to open any DeZurik Easy-Operating Plug Valve WIDE OPEN or close it ABSOLUTELY SHUT! DeZurik's exclusive Eccentric Action provides the smoothest, simplest, surest operation of any plug valve.

The unique DeZurik Plug is rubber-faced on a rigid metal core. This plug delivers a conforming closure against the metal seat, closes 100% drip-tight even with solids intervening, won't ever distort, needs no reseating, no maintenance.



DeZURIK VALVES will excel in a whole range of petroleum process applications: on gasoline and diesel fuel loading racks, lube grease lines, refinery gases, bleeder lines to butane and propane kilns, furnace burner valves, and many others.

In sizes from ½" thru 20", with manual, pneumatic, hydraulic or electric operators. Representatives in principal cities.

Write for details.

DEZURIK
SHOWER COMPANY
SARTELL, MINNESOTA

Belden joined Carbide after his graduation in 1934 from Yale with a B.S. in industrial engineering. From 1947 to 1954 he was assistant superintendent of the Texas City plant. In the latter year he was given the superintendent's job at South Charleston.

With the company since 1936, Hieronymus holds a B.S. in civil engineering from the University of Illinois. He has been assistant superintendent at Texas City since November, 1954.

Stuewe started with the company in 1936 after his graduation from the University of Wisconsin with a B.S. in mechanical engineering. Since December of 1947 he has been area supervisor at Texas City.

Milburn J. O'Neal, Jr., of Shell Oil Co.'s Houston laboratory, has been given this year's Precision Scientific Co. award in petroleum chemistry. A group leader in analytical research, O'Neal is credited with having modified the mass spectrometer so that it can be used to identify heavier oil fractions.

Mr. O'Neal

He received a B.S. degree in chemistry from the University of Texas in 1944 and joined the Shell research staff the same year. He became a group leader in 1953.

Charles O. Koch, formerly at the New Martinsville, W. Va., plant of the Mobay Chemical Co., has joined the development department of the firm in St. Louis. He will work on the commercial development of urethane foams and surface coatings.

Koch's post at New Martinsville, technical service superintendent, has been given to **Ray M. Ewald,** who has been with Mobay's engineering department since 1954.

Frederick W. Enoch has become manager of the electrical and instrumentation sections, engineering department, of Monsanto Chemical Co.'s organic chemicals division. He succeeds **William J. Katt,** who has transferred to the automatic process control group in the research and engineering division.

In the Lion Oil Co. division of Monsanto, **Malcolm C. Lowe, Peter D. Burland,** and **Charles L. McDaniel** have been appointed group leaders in the development department, which is located at the Barton plant, Luling, La.

Lowe was chief chemist at the Barton plant and has been with Lion since 1942. Burland was with Monsanto at Texas City until his assignment with Lion Oil. McDaniel was formerly a supervisor of field technical service in Lion's chemical sales department.

George T. Piercy, general manager of Esso Standard Oil Co.'s supply division, has been elected a director of the Plantation Pipe Line Co. He was in refining coordination from 1951 to 1953, was made assistant general manager of the supply department in 1954, and a year later became general manager.

Reynold E. Kontak has been appointed general foreman of thermal and catalytic cracking units at Sun Oil Co.'s Toledo refinery. Kontak succeeds **Roy J. Sayers,** who was recently transferred to the Marcus Hook refinery as general foreman of a new catalytic cracking unit.

B. W. Thomas has been promoted to senior research specialist at Humble Oil & Refining Co.'s Baytown refinery. **E. M. Amir** and **B. H. Johnson** have moved to senior research chemists, and **M. T. Waddell** to patent coordinator.

In the technical service division, **B. S. Greenwood** has been made technical specialist and **W. E. Askey** senior chemical engineer. **C. H. Marshall** has become section head of the solvents section.

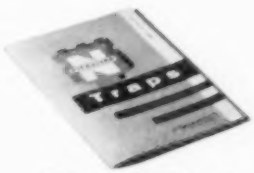
R. S. Conly has been named assistant general foreman of the light ends department in the process division. **C. A. Hansen, Jr.,** and **J. W. Ferrell** have been promoted to assistant general foreman and foreman, respectively, of the cracking and polymerization department.

New staff men at the refinery are as follows: in research and development, **Douglas C. Benton,** B.S. in chemical engineering, Oklahoma A. & M. College; **Robert L. Hull,** Ph.D. in chemistry, University of Texas. In technical service, **Billy B. Ashby,** Ph.D. in chemical engineering, University of Michigan; **Robert L. Norris,** B.S. in chemical engineering, Louisiana Polytechnic Institute; and **J. R. Lawley,** B.S., and **Mervin Rosenbaum,** M.S., in chemical engineering from the University of Texas.

Engineering division has added **Leonard Braswell,** B.S. in mechanical engineering at Alabama Polytechnic Institute.

Nicholson *steam trap* simplicity *gives you*

peak performance, low-cost maintenance



Write, today, for your copy of new Bulletin 10-55 for detailed information.

Nicholson simplicity of design and operation pays off big in any plant . . . in peak performance for petroleum processing . . . in easy, low-cost maintenance. Nicholson traps offer the most effective method for discharging condensate and air from steam lines.

- **one moving part—big husky bellows.**
- **positive shut-off—no waste of steam.**
- **high capacity—effective use of large orifice.**
- **each unit service tested—with steam.**

When less than the best won't do, specify Nicholson.

NICHOLSON

W. H. NICHOLSON and Company

TRAPS • VALVES • FLOATS • METAL PARTITIONS
LAUNDRY, DRY CLEANING AND PRESSING MACHINERY

14 OREGON STREET, WILKES-BARRE, PA. • SALES AND ENGINEERING OFFICES IN 98 PRINCIPAL CITIES

(To obtain more data on advertised products see page 174)

G-B DISTRIBUTORS

Amarillo, Tex. . . DRake 3-5563
Atlanta . . . SYcamore 4-9511
Billings, Mont. . . 9-2419
Birmingham, Ala. . . 4-6722
4-5461
Brookline, Mass.
LOngwood 6-8381
Buffalo, N. Y. . . PArkside 3710
Charleston, W. Va. . . 3-9467
Charleston Hts., S. C. . . 4-5973
Chicago . . . WAterfall 8-8135 or
FUlton 5-0550
Cincinnati . . . CHerry 1-7435
Cleveland . . . SKyline 1-4200
Columbia, S. C. . . 2-3361
Columbus, Ohio . FAirfax 6033
Dallas, Tex. . . PRospect 7300
Davenport, Iowa . . . 2-6205
Denver, Colo. . . CHerry 4-6569
Detroit . . . TAshmoo 5-6000
El Paso, Tex. . PRospect 2-7491
Fargo, N. D. . . . 4411
Ft. Smith, Ark. . SUnset 3-1155
Ft. Wayne, Ind. . ANthony 8482
Ft. Worth, Tex. . FOrtune 4827
Greensboro, N. C. . . 2-5250
Gulfport, Miss. . . 3866
Houston . . . JAckson 9-4649
Indianapolis . . . MElrose 5-3451
Jackson, Miss. . . 3-3597
Jacksonville, Fla. . . 6-7636
Joplin, Mo. . . MAyfair 4-4366
Kansas City, Mo. . GRand 1-0700
Little Rock . . . FRanklin 2-7221
Los Angeles . . . ANgelus 3-6961
Louisville . . . JUniper 4-7845
Memphis . . . JAckson 6-7321
Miami, Fla. . . 65-2595
Nashville, Tenn. . . 4-6661
New Haven . . . MAin 4-7682
New Orleans, La. . . CAnal 7781
New York . . . WOrth 4-8550
Oklahoma City . . . REgent 9-2825
Omaha, Nebr. . . . ATlantic 1155
Philadelphia . . . GArfield 6-8240
Pittsburgh . . . CHurchill 1-7100
Phoenix, Ariz. . . . ALpine 4-9764
Raleigh, N. C. . . . 2-3501
Richmond, Va. . . . 62-6748
Rockford, Ill. . . . 2-3711
Salt Lake City . . . ELgin 9-1966
San Antonio . . . TAylor 2-1509
San Francisco . . . SUtter 1-5967
Savannah, Ga. . . . 62461
Schenectady, N. Y. . . . 78770
Seattle, Wash. . . . SEneca 7250
St. Louis . . . CHestnut 1-0445
St. Paul . . . Midway 6-7865
Syracuse, N. Y. . . . 73-0216
Tampa, Fla. . . . 4-4911
Tulsa, Okla. . . . CHerry 2-3145
Tupelo, Miss. . . . 2245
Washington, D. C. . . . AD 4-1928
Wichita . . . AMherst 7-7195

See our catalogs in
Sweet's Architectural &
Plant Engineering Files

GUSTIN gb BACON

It's a "snap" to insulate Steam-Traced lines with SNAP*ON

. . . and it's a "snap", too, to insulate fittings, bends, couplings, cast iron pipe—any irregular piping.

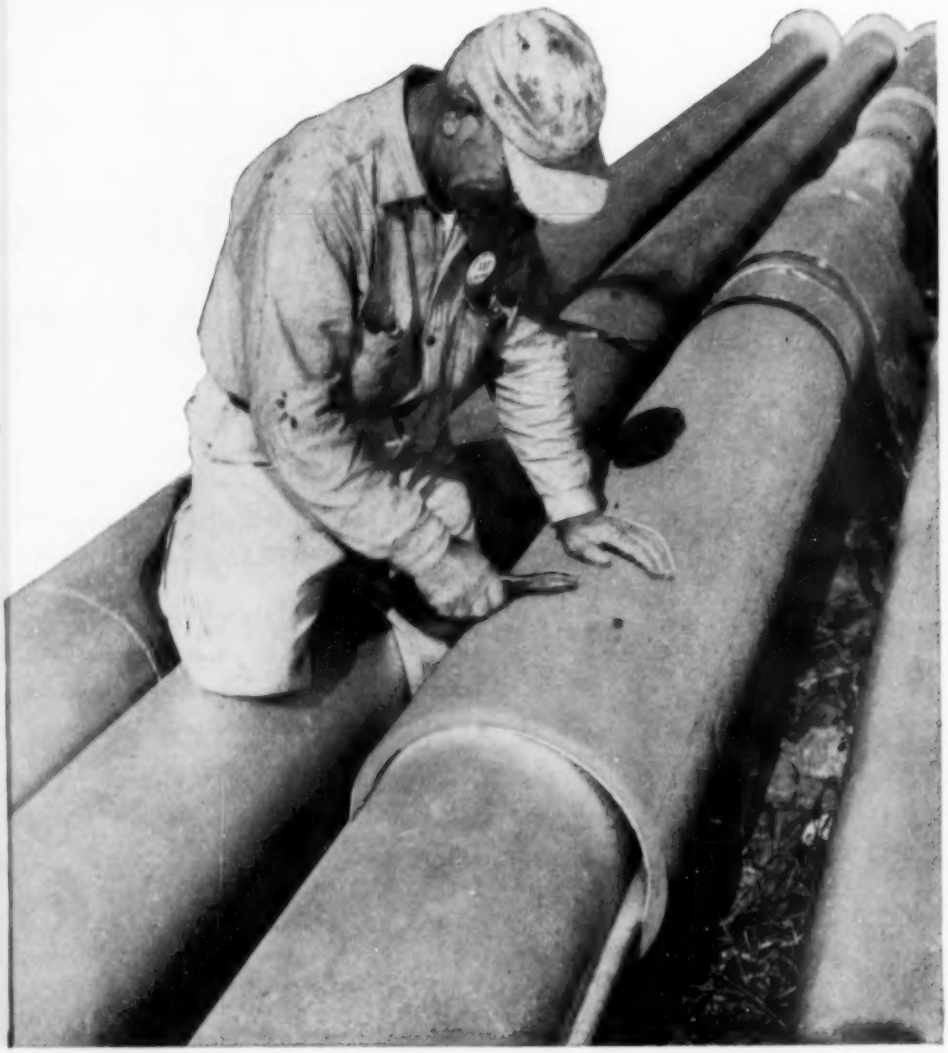
Snap*On is a flexible, resilient, one-piece pipe insulation molded of fine glass fibers that actually snaps on the pipe. Made in sizes up to 33" I. P. S. and in sections 6 feet long, **Snap*On** cuts the cost of insulating big pipe to a minimum. Once on the pipe, **Snap*On's** flexibility prevents cracking under thermal contraction and expansion.

Snug fit and easy application are by no means the only reasons why you'll want to use **Snap*On** for both hot and cold piping. Thermally, it is superior to any other pipe insulation on the market. It's clean and dustfree. It's attractive, easy to finish. And **Snap*On** is as permanent as a pipe insulation can be, yet can easily be removed and reused. If you can't say as much for your present pipe insulation—

CALL YOUR LOCAL SNAP*ON DISTRIBUTOR TODAY
(HIS PHONE NUMBER IS IN THE ADJOINING COLUMN) **or**
WRITE FOR YOUR COPY OF NEW SNAP*ON BROCHURE

GUSTIN-BACON *Manufacturing Company*

266 W. 10th St., Kansas City, Mo.



Dr. Hart Joins Wastes Firm

W. B. Hart, an authority on the treatment of industrial and sewage wastes, has become director of the industrial wastes engineering division of Pantech, Inc., Folcroft, Pa.

For more than 30 years Dr. Hart directed the waste control division of the Atlantic Refining Co. He is the only active member of the original committee for disposal of refinery wastes of the American Petroleum Institute and was the committee's chairman from 1940 to 1946.

Pantech is a firm of consulting engineers in chemical and biological treatment and disposal of industrial wastes.

Boyd Heads Blaw-Knox Dept.

Noel F. Boyd has been appointed chief process engineer in charge of the process department of Blaw-Knox Co.'s Chemical Plants Division. He was promoted from assistant chief process engineer. William W. Lawrence has been made Mr. Boyd's assistant and will be in charge of chemical process work. Claude E. Durgee has been made assistant in charge of the layout department activities.

Mr. Boyd

Mr. Boyd was previously with Carnegie Illinois Steel Corp. and Standard Oil Co. (Ind.), where he spent a number of years in process design, pilot plant and technical service work. At Blaw-Knox he has also served as supervising process engineer in the design of chemical and process plants.

Mr. Lawrence joined the company in 1945 and much of his work has been on atomic energy commission projects. He is a graduate of Carnegie Institute of Technology.

Mr. Durgee has been principal engineer in the layout department of Blaw-Knox, where he was in charge of all departmental work.

New Canadian Fabricating Firm

T.I.W. Western Ltd. is a new metal fabricating firm at Edmonton, Alta. It was formed by Toronto Iron Works Ltd. and the Canadian Kellogg Co. Ltd. It will use the manufacturing shops Kellogg has in Edmonton and will carry on the work both firms offer their customers. Certain additional facilities will be installed so that the new firm can fabricate steel storage tanks and various lines of steel and alloy-steel plate products for the western Canada customers of Toronto Iron Works.

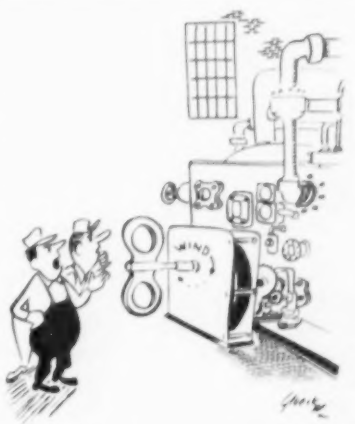
Officers of the new company have been drawn from both firms. President is G. E. Ellsworth; vice-president, Benton Dixon and D. W. Champlin; Secretary-treasurer, R. A. Baggott. R. T. Valentine is general manager of the firm, and Kellogg's present staff at Edmonton will be retained.

FIRST TEN YEARS of Catalytic Construction Co. are the occasion of these congratulations. In the foreground, left to right, are Clarence H. Thayer, Sun Oil Co., vice-president; T. Ellwood Webster, president of Catalytic; and C. G. Kirkbride, president of Houdry Process Corp., Catalytic's parent company. In the background are, left to right, W. Graham Jamison, Catalytic vice-president, Alan T. Knight, Catalytic, and C. C. Peavy, Houdry vice-president

Five Receive NCA Safety Awards

Safety awards have been given to five members of the National Constructors Association for safety records that better the association average. They are Chemical Construction Co., M. W. Kellogg Co., Koppers Co., Procon, Inc., and Rust Engineering Co.

In 1955, the association's member companies had an average frequency rate of 16.1 and an average severity rate of 0.85. This compares with 1954 figures (the latest available) in the construction industry generally of 17.29 an 2.29.



"Him and his economy moves—who's gonna wind it?"

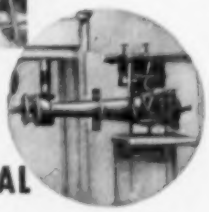
Washburn Takes Beckman Prize

Dr. Harold W. Washburn, principal inventor of the analytical mass spectrometer, has received this year's Beckman award in chemical instrumentation. The $1000 award was presented to Dr. Washburn, who is vice-president and director of research at Consolidated Electrodynamics Corp., at a recent national meeting of the American Chemical Society. During the meeting, a special program in his honor was held by the ACS Division of Analytical Chemistry.

Dr. Washburn

Dr. Washburn took his B.S. in mechanical engineering in 1924 from the University of California at Berkeley. He became an instructor of electrical engineering at M.I.T. and received an M.S. in electrical engineering in 1927.

VERTICAL



OR

HORIZONTAL

many more hours on stream without forced shutdown with NATIONAL AIROIL

OIL-GAS TANDEM COMBUSTION UNITS

Exclusively for vertical firing, the new National Airoil VERTICAL Tandem Block Units retain all the features of our regular horizontal Tandem Units . . . *plus:* special, pre-cast refractory shapes for easier, cost-saving vertical installation and maintenance; secondary air inlet louvres for positive control of vertical flame pattern; and, all steel duplex detaching gear which enables swift, simple vertical burner changeover.

VERTICAL and HORIZONTAL Tandem Units hold air in the combustion zone until fuel and heated air are thoroughly mixed. This means that ignition takes place in a hot zone; the result: high fuel economy through more rapid combustion with a minimum of excess air. NATIONAL AIROIL's patented Tandem Combustion Units allow secondary air to be easily and accurately controlled. By adjusting air control louvres, flame can be shaped to radiate heat uniformly without tube impingement.

The VERTICAL or HORIZONTAL Tandem Unit is always fired with NATIONAL AIROIL Combination Oil and Gas Burners . . . has a high turndown ratio with a steady flame temperature using either fuel oil or gas. With the TANDEM UNIT'S clean flame, a cold furnace can be brought to full capacity in a short time.

"Many, many more hours on stream, without shutdown" . . . yes, YOU will realize higher profits from YOUR heaters when NATIONAL AIROIL VERTICAL or HORIZONTAL Tandem Units are specified. Our new Bulletin 498 is yours for the asking.

CHEMICAL-PETROLEUM DIVISION

NATIONAL AIROIL BURNER CO., INC.

1297 EAST SEDGLEY AVE., PHILA. 34, PA.
Southwestern Division
2512 South Boulevard, Houston 6, Texas
INDUSTRIAL OIL BURNERS, GAS BURNERS, AND FURNACE EQUIPMENT

He then joined the California school's faculty and simultaneously worked for his Ph.D., which he was awarded in 1932. After two more years on the M.I.T. faculty he became chief physicist of the research lab for Western Geophysical Co. In 1937 he was made vice-president of Consolidated Engineering Corp.

He has been working in the field of mass spectrometric analysis since 1938 and directed the construction of the first mass spectrometer for analytical work in 1940.

Wiseman New Head of CTI

James P. Wiseman, president of Fluor Products Co., has been elected president of the Cooling Tower Institute for 1956. The Institute is an association of the major manufacturers of industrial water-cooling towers and is located at Palo Alto, Calif.

Mr. Wiseman

Other officers elected for new terms are Forrest B. Reed, Marley Co., vice-president; Karl E. Johnson, J. F. Pritchard & Co., secretary; and Denis E. O'Neil, Foster Wheeler Corp., treasurer.

Wyatt Boosts Production

Expansion programs have been started at the Houston and Dallas fabricating plants of Wyatt Metal & Boiler Works. Enlargement at Houston will enable more efficient production of the larger and heavier processing vessels used in petroleum and petrochemical processing. Shop extensions and additions to the craneway space make it necessary to shift all the rail facilities in the Houston plant yard.

At Dallas more and larger bays will be employed for making trays, bubble caps, and both carbon and steel alloys. A new press brake, two new punch presses and other major pieces of equipment are being added to the plant's facilities.

The company expects the expansion program to increase producing capacity materially.

Shelley Heads Engineering Firm

Dushell Engineering, Inc., a firm of contract engineers and consultants for refineries, chemical and natural gasoline plants, has been formed by Guy M. Shelley and F. Duane Fuqua. Mr. Shelley, president, was for many years chief engineer of the Winkler-Koch Engineering Co. and the Koch Engineering Co. He also operates a company under his name which does work in structural design, piping layouts, fueling systems and refinery revamp work.

Mr. Fuqua used to be vice-president of engineering and engineering sales for Koch Engineering Co. More recently he was in charge of Koch's European operations. With Dushell, he is excutive vice-president.

Others in the firm are Guy M. Shelley, Jr., and R. J. King, both formerly with Koch.

Dushell Engineering is at 321 W. Douglas St., Wichita, Kan.

Brick Plant to Go up in Canada

A new plant for making fire brick and refractory specialties will be constructed by General Refractories Co. of Canada at Smithville, Ont. The new plant is 20 miles from the steel town of Hamilton and in the middle of a fast-growing industrial area.

The Smithville plant will make the company's basic fire brick, the steel encased "Steelklad" and the "Ritex" bricks, as well as mortars, castables and other specialties.

Personnel Changes

Perkin-Elmer Corp.—Dr. Van Zandt Williams to general manager of the newly formed instrument division, which will develop, produce and sell the company's line of process control and laboratory analytical instruments.

Beckman Instruments, Inc.—Thomas Scatchard to plant manager of the Berkeley division. He was formerly with Marchant Calculators, Inc.

Philip Carey Manufacturing Co.—Robert F. Turner to sales promotion manager of this firm of insulation manufacturers.

Pfaudler Co.—Dewey R. Holcombe to manager of the chemical equipment sales department. He was formerly manager of the Detroit sales office.

Wolverine Tube Div.—William R. Morrisey to sales representative in Pittsburgh and surrounding area; Raymond B. Davis to sales representative for the east-central section of the U.S.

Fluor Corp., Ltd.—Loren Miller, formerly with du Pont Co., to research chemical engineer; Dr. Robert C. Oliver, previously with Union Oil Co.,

BETZ • *A Great Name*
In Water Conditioning

"Prescriptions" by the truckload!

Solving industrial water conditioning problems effectively and *economically* requires exacting engineering techniques.

There are no stock answers . . . no stock chemical treatments.

We realize this perhaps more than anyone. In fact, we make a business of it.

For example, each year at our mixing and formulating plants in Pennsylvania, Texas, California, and Quebec, we blend and ship thousands upon thousands of different "prescriptions", each specifically job-engineered to solve some individual water conditioning problem for industry. Because we feel it is so important to "tailor-make" our formulations, each of our plants actually performs the function of a giant industrial pharmacy.

The blending and shipment of our chemical formulations is, however, only one important part of our *completely-individualized* water conditioning service. Individual investigations, plant control methods, daily testing programs, periodic checkups, analyses of water samples, and regular engineering reports all combine to provide a water conditioning service that is complete in every detail.

The end result of individual attention to individual problems is obvious . . . the assurance of a plant (perhaps your own) operating at peak efficiency, free from water problems.

A 20-minute, no obligation discussion of your plant water problems with a Betz District Engineer is the best investment in time you can make. Call him in today.

W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa. In Canada: BETZ Laboratories Limited, Montreal 1.

■ CONSULTANTS ON INDUSTRIAL WATER PROBLEMS

(To obtain more data on advertised products see page 174)

to senior research engineer; Dr. Donat B. Brice, formerly with Food Machinery & Chemical Corp., to research chemical engineer; Paul H. Dutch, who was with U.S. Testing Laboratories, to research chemist.

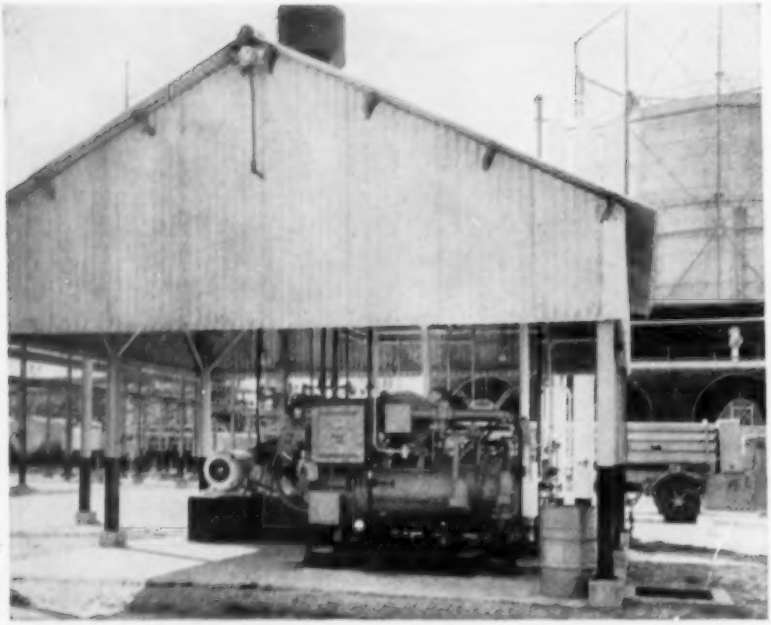
U.S. Steel Supply Div.—Ralph T. Beasley to district product representative for alloy, stainless and tubing sales, with offices in Houston.

Rhodia, Inc.—Dr. Jacques P. Sibeud to manager of laboratories. He was formerly with Rhone-Poulenc, Paris.

Houdry Process Corp.—George F. Hornaday to assistant manager of process sales; Dudley Beyler to product sales engineer in the chemicals division.

Chiksan Co.—Edwin P. Illsley and John E. Burkett to the sales staff operating out of the Brea office; Joseph P. Beyer to the sales staff headquartered at the Oakland office.

Catalytic Construction Co.—Ambrose C. Martinsen to chief project manager of the engineering division, a new position.

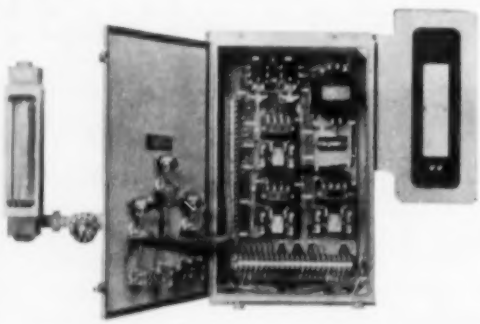


ESSO USES GAS ATMOSPHERES' MODERN INERT GAS SYSTEM

Gas Atmospheres' advanced automatic turndown system and interconnecting control for operation in conjunction with compressors sold Esso Standard Oil Company on the new Gas Atmospheres' Inert Generator for petroleum processing.

This compact generator unit delivers 10,000 cfh of inert gas. Esso uses the gas to purge lines and tanks before filling with a different material, and for displacing undesirable vapors during process and storage at their large pilot plant installation at Baton Rouge, Louisiana.

The generator is the most modern unit of its kind in the industry. If you, like Esso, want the most modern and economical gas generation equipment possible, then contact Gas Atmospheres first.



Compact, unitized, neatly arranged control panel for new Gas Atmospheres' Generator Line.

9905

gas Atmospheres, inc

equipment for producing industrial gases

20011 WEST LAKE ROAD CLEVELAND 16, OHIO

ERNST

STAINLESS STEEL

GAGE OR IRON

Send for Catalog

Phone Livingston 6-1400

ERNST WATER COLUMN & GAGE CO.

LIVINGSTON, N. J.

When The Owner's Manual Says

"use V.H.D. oil only"

Barium-based Additives Will Still

Provide an Extra Measure of Protection

Today, 75% of detergent additives are barium based. As compression ratios go up, chances are that an even greater percentage of tomorrow's V.H.D. oils will contain barium-based additives.

Anticipating the trend, we recently increased capacity 100% . . . and stand ready to increase again. We pioneered flake Barium Octahydrate and Barium Pentahydrate . . . advanced forms of soluble barium values now widely used. We also have acquired another large mineral deposit to increase further ore reserves. These efforts continue.

Yes, you can be sure when the owner's manual specifies "V.H.D. Oils Only", we still expect to be America's largest producer of barium alkalis for oil additives.

If you are working with lube oil additives, we would like you to have a copy of this new, 24-page booklet giving complete information on WESTVACO® Barium Chemicals. Send for it now.

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

Westvaco CHEMICALS

Westvaco Mineral Products Division

FOOD MACHINERY AND CHEMICAL CORPORATION

General Offices • 161 East 42nd Street, New York 17

CHICAGO, ILLINOIS • CINCINNATI, OHIO • HOUSTON, TEXAS • NEWARK, CALIFORNIA

CANADIAN COMMITTEE for the Twenty-First Mid-Year Meeting
Division of Refining — American Petroleum Institute
1425 Mountain Street — Montreal 25, Quebec

A. G. FARQUHARSON, *Chairman*
McColl-Frontenac Oil Co. Ltd.

H. B. BARTON
McColl-Frontenac Oil Co. Ltd.

B. BROUILLET
Imperial Oil Limited

D. L. CAMPBELL
The British American Oil Co. Ltd.

G. DAVIDSON
Shell Oil Company Ltd.

F. J. HIMBURY
Canadian Oil Companies Ltd.

G. L. MACPHERSON
Imperial Oil Limited

W. HAROLD REA
Canadian Oil Companies Ltd.

MRS. MURIEL SMALL
Imperial Oil Limited

J. P. THIBERT
The British American Oil Co. Ltd.

F. O. WALKLING
Shell Oil Company Ltd.

K. A. WEST
Canadian Oil Companies Ltd.

J. H. YOCOM
The British American Oil Co. Ltd.

To All Refining Members of the Petroleum Industry:

BIENVENUE A MONTREAL AU MOIS DE MAI!

If your French is still a little rusty, don't worry. When you come to Montreal for the mid-year meeting of the A.P.I. Division of Refining, you will find that no matter what language you speak it will certainly be a case of "French without tears," as the saying goes.

In fact, as an article on Montreal in this issue of Petroleum Processing (pp. 70 and 71) tells you, a visit to Montreal has the Gallic charm of a stay in Paris itself.

Your Canadian hosts are looking forward to making this one of the outstanding mid-year meetings in the history of the A.P.I. As the first meeting outside the U.S. in A.P.I. history, it has been a happy international challenge to us. We are planning on visitors having the best possible time, both in and out of sessions.

We won't say anything about the program - because details on it appeared in the March Petroleum Processing - except that it promises to have the breadth and depth to do the best possible job of keeping you up-to-date on the world's most exciting industry.

We won't say anything about the special program for the ladies, except that Montreal is famed for its shops and points of interest.

We won't say anything about unique Montreal as a major petroleum processing centre - already you have read about that, including an article in this magazine just last month - except to invite you to drop around and see those Canadian plants.

We do say that if you have any doubts about coming up next May 14-17, forget them right now. If you can say "Oui, oui!" your French is good enough. Your Canadian committee will look after the rest.

Sincerely,

A. G. Farquharson

A. G. Farquharson, Chairman

AGF:wb

Details of ASME Petroleum Meeting

SESSIONS on refining economics, mechanical design, maintenance, and other topics close to the heart of the petroleum refiner will be presented when the American Society of Mechanical Engineers offers its 11th annual Petroleum Mechanical Engineering Conference. Location is Dallas, and the meeting will run from September 24 to 26.

Here is the tentative program drawn up by the refining committee.

Refining Economics

"The Economics of Installation and Operation of Centrifugal Compressors Driven by Combustion Gas Turbines," by A. L. Vaughn, Northern Natural Gas Co.

"Practical Economics for Refining Mechanical Engineers," by T. S. Fennema, Humble Oil & Refining Co.

Job Evaluation and Industrial Psychology

"Job Evaluation," by A. de Leon, Warren Petroleum Corp.

"Some Industrial Psychology Application," by J. M. Parish, Dow Chemical Co.

Air Cooling

"Air Cooling—The Purchaser's Viewpoint," by T. H. King and Dave Brown, Magnolia Petroleum Co.

"Problems of a Manufacturer of Air Fin Coolers and Suggested Solutions," by J. I. Carter, Arrow Industries.

Panel Discussion—ASA B31 Piping Code

Chairman: F. S. G. Williams, Taylor Forge & Pipe Works.

Panel members to be announced.

Maintenance

"Maintenance Problems in Petrochemical Plants," by P. S. Shaff, Sabine River Works, du Pont Co.

"Maintenance Organization in a Modern Refinery," by C. H. Trotter, Phillips Petroleum Co.

Mechanical Design

"Hydraulic Drives," by B. J. Thompson, Warren Petroleum Corp.

"Process and Equipment Problems Associated with Catalytic Reforming and Related Processes," by Robert Bent, Atlantic Refining Co.

"High Pressure Mechanical Design Problems," by C. E. Freese, Fluor Corp.

Design and Construction

"Use of Models in Plant Design and Construction," by Bruce L. Paton, Fluor Corp.

"One way to Stay Within Your Construction Budget," by J. E. Ross, Dow Chemical Co.

Panel Discussion—ASME Unfired Pressure Vessel Code

Chairman: E. O. Bergman, C. F. Braun & Co.

Panel members to be announced.

NSPE Annual Planned for Atlantic City, May 23-26

May 23 to 26 is scheduled for the annual meeting of the National Society of Professional Engineers. This year the event will be at the Ambassador Hotel in Atlantic City, N.J.

A feature of the meeting will be a series of four conferences dealing with the role of engineers in government, industry, education, and consulting practice. Leading engineers in each field will appear before the conference.

Also, the annual NSPE award for meritorious service to the profession will be made at the May 26 banquet.

Papers on Octanes at SAE Summer Meeting

Papers on the comparison of laboratory and road octanes will be among those heard at the summer meeting of the Society of Automotive Engineers. The event will be held in the Chalfonte-Haddon Hall at Atlantic City, June 3 to 8.

Following is a selection of the papers to be read during the meeting:

"Correlation Between Laboratory and Engine Performance of Synthetic Turbine Lubricants," by T. F. D. Davidson and J. H. Way, Wright Air Development Center.

"Fuel Anti-Knock Performance in High-Compression Engines," by C. J. Domke, N. D. Esau, D. S. Gray and H. R. Taliaferro, Standard Oil Co. (Ind.).

"Octanes—From Lab to Road," by E. S. Corner, Esso Research & Engineering Co.

"An Approach to Obtaining Road Octane Ratings in a Single-Cylinder Engine," by E. M. Barber, H. I. Wilson, and T. H. Randall, The Texas Co.

"Automotive Air Conditioners and Gasoline-Volatility Requirements," by M. R. Morrow, Humble Oil & Refining Co.

Besides the sessions it sponsors, the Fuels and Lubricants Activity will hold a committee meeting June 5.

The Society's Horning Memorial Award will be given this year to Joseph T. Wentworth and Wayne A. Daniel, both of the General Motors Corp.

Going to Montreal?

The Refining Division of the API has its big mid-year meeting lined up for May 14-17 at Montreal. You won't want to miss it, and in this issue we have given you complete information about the activities at the meeting. For further details see the opposite page and pp. 93 to 108 of this issue.

Latest in Research at AAAS Gordon Conferences

The Gordon Conferences of the American Association for the Advancement of Science will be held at three locations through the latter half of June and until August 31. The sessions at Colby Junior College, New London, N.H., include several topics of interest to the petroleum refiner or research man. One of these, on petroleum, will offer the following papers in sessions meeting between June 18 and 22:

"Preparation and Decomposition of Hydroperoxides," by H. S. Mosher.

"Application of Thermodynamics to Petroleum Problems," by Guy Waddington.

"Reactions of Mercaptide Radicals with Hydrocarbons," by Cheeves Walling.

"Aliphatic Intramolecular Chain Transfer Reactions," by D. F. DeTar.

"Double-bond Migration and Racemization of Olefins During Hydrogenation," by W. O. Huntsman.

"The Influence of Radiation on Thermal and Catalytic Cracking, Hydroforming, Alkylation, and Petrochemical Reactions," by H. A. Ohlgren.

"Hydrocarbons as Reactor-Moderator Coolants," by R. O. Bolt.

"Separation of Sulfur Compounds from Petroleum," by S. R. Birch.

"The Fruits of Petroleum Chemistry," by O. V. Tracy.

"Applications of Nuclear Magnetic Resonance to Petroleum Problems," by R. B. Williams.

In addition, there will be sessions on catalysis, separation and purification, polymers, corrosion, and instrumentation.

Director of the conferences is Prof. W. George Parks, department of chemistry, University of Rhode Island.

Chemical Plant Corrosion Topic at NACE Group Meet

Corrosion control in the chemical industry will be the theme of the symposium sponsored by the Niagara Frontier Section, National Association of Corrosion Engineers, and the University of Buffalo, May 9 and 10. The meeting will be held at the university campus. Papers to be presented are these:

"Fundamentals of Metallic Corrosion," by M. Stern, Metals Research Laboratories.

"Iron Base Alloys," by S. H. Kalin, U.S. Steel Corp.

"Stainless Steels," by C. P. Dillon, Carbide & Carbon Chemicals Co.

"Copper and Nickel-base Alloys," by H. O. Teeple, International Nickel Co.

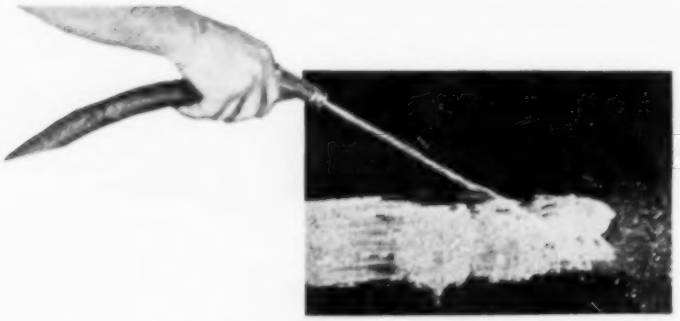
"Aluminum and Magnesium Alloys," by H. P. Goddard, Aluminum Laboratories.

"Metallic Coatings," by W. W. Bradley, Bell Telephone Laboratories.

"Lead," by K. H. Roll, Lead Industries Assn.

Amazing new stripper for removing paint!

BRUSH IT ON



RINSE IT OFF

Take a stop watch in one hand and a brush full of Oakite Composition No. 57 in the other and see for yourself how this amazing new paint stripper goes to work in seconds ... practically lifting the paint behind the brush.

See how Oakite Composition No. 57, paint stripper extraordinary, clings to vertical and inverted surfaces, eliminating costly waste. How easily loosened paint rinses away with water pressure spray.

Oakite Composition No. 57 is tops for removing those tough alkaline resistant paints from surfaces that just can't be dip-stripped. Get the full story today by writing for Special Report B–2415 and the Paint Stripping Handbook F–7893. Both FREE.. Write Oakite Products, Inc., 44C Rector St., New York 6, N.Y.

SPECIALIZED INDUSTRIAL CLEANING
OAKITE
MATERIALS · METHODS · SERVICE
SCIENCE

Export Division
Cable Address: Oakite

Technical Service Representatives in Principal Cities of U. S. and Canada

"Titanium, Zirconium and Tantalum," by W. E. Lusby, Jr., du Pont Co.

"High-Alloy Materials," by E. D. Weisert, Haynes Stellite Co.

"Chemical Plant Problems," by M. G. Fontana, Ohio State University.

AIChE Group to Discuss Communications May 6-9

A symposium on communications in industry will be part of the New Orleans, La., meeting of the American Institute of Chemical Engineers. Scheduled for May 6 to 9, the event will take place at the Roosevelt Hotel.

Papers in the communications session are as follows:

"What Management Expects of Technical Reports," by G. W. Beste, Ethyl Corp.

"What Editors Expect of Engineering Articles," by John B. Mellecker, *Chemical Engineering Progress*.

"What Engineers Can Do to Improve Their Writing," by Henrietta Tichy, Hunter College, New York.

"What Management Can Do to Improve Communication," by Dennis Murphy, Service Pipe Line Co.

A general session will present the following papers:

"Phase Separation and Mass Transfer in a Liquid-Liquid Cyclone," by D. J. Simkin and R. B. Olney, Shell Development Co.

"Development of a Two-Stage BHC Photochemical Reactor," by L. J. Governale and J. T. Clarke, Ethyl Corp.

"Effect of Concentration Level on Mass Transfer Rates," by L. E. Westkaemper and Robert R. White, University of Michigan.

"Multicomponent Distillation-Trays at an Operating Reflux," by James B. Bachelor, Ralph M. Parsons Co.

Other topics at the meeting are symposiums on Fundamental Mechanisms in Boiling, Cavitation and Condensation, Foreign Chemical Developments and Their Effect on the U.S. Chemical Industry, and Liquid Metals.

Oil Man's Calendar

MAY

Petroleum Industry Electrical Assn., annual, Statler Hilton Hotel, Dallas, May 1-3.

American Institute of Electrical Engineers, northwestern district, Rochester, N.Y., May 2-4.

Liquefied Petroleum Gas Assn., convention and trade show, Conrad Hilton Hotel, Chicago, May 6-9.

American Institute of Chemical Engineers, national meeting, Roosevelt Hotel, New Orleans, May 6-9.

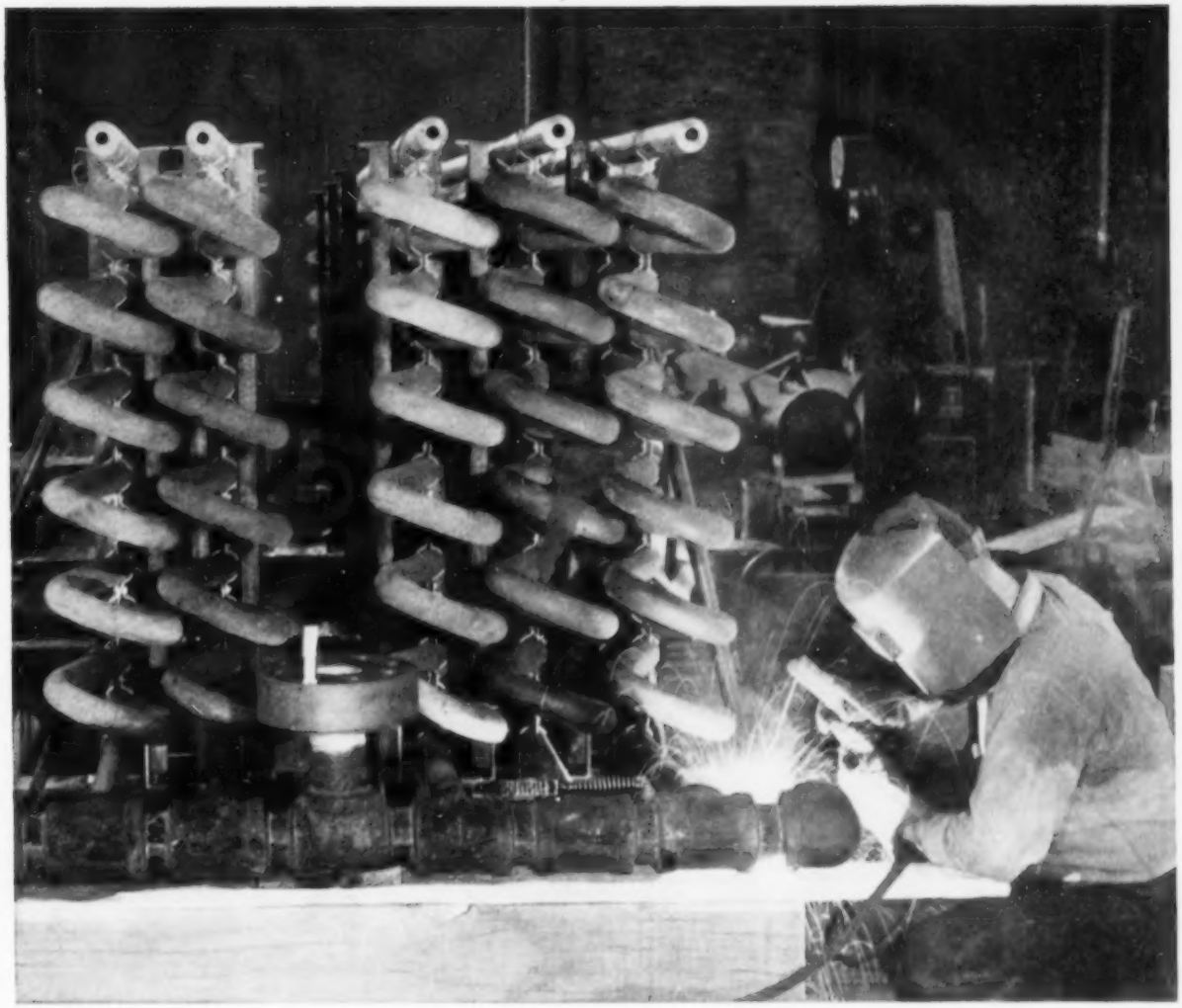
National Assn. of Corrosion Engineers, Niagara Frontier Section, symposium on control of corrosion in the chemical industry, University of Buffalo, May 9-10.

American Welding Society, annual, Memorial Auditorium, Buffalo, N.Y., May 9-11.

Petroleum Electric Power Assn., annual, Robert Driscoll Hotel, Corpus Christi, May 14-16.

American Petroleum Institute, Refining Division mid-year meeting, Sheraton-Mt. Royal Hotel, Montreal, May 14-17.

11th Purdue Industrial Waste Conference,



Putting the Chill on NH_3

The Vilter Manufacturing Co. of Milwaukee, Wis., makes, among other interesting and useful products, ammonia (NH_3) synthesis coolers. These coolers must contain the newly-made hot gas at a pressure of 10,000 psi and reduce its temperature by means of cooling water conducted over the tubes.

To meet its exacting requirements, Vilter chose B&W Seamless Tubing, made for high-pressure service. All tubing in these coolers is tested at 15,000 psi.

To bend these heavy-wall tubes to a 4″ radius, 3⅛″ off the vertical plane, is evidence of Vilter's skill and craftsmanship at work.

And for evidence of how B&W tubing can help improve your own skill and craftsmanship, get in touch with Mr. Tubes, or write for Bulletin 408. The Babcock & Wilcox Company, Tubular Products Division, Beaver Falls, Pa.

TA6032 P

Seamless and welded tubular products, seamless welding fittings and flanges—in carbon, alloy and stainless steels

ALUMINUM GRATING WALKWAY & HANDRAILING

A typical installation frequently used in the petroleum industry.

See us also for:

- **Pressure Vessels**
- **Heat Exchangers**
- **Storage & Processing Tanks**
- **Towers**
- **Gratings**

Our pressure vessels and tanks are designed and built to comply with the requirements of the ASME code and we are authorized to apply the appropriate symbols.

WASHINGTON ALUMINUM CO., Inc.

BALTIMORE 29, MD. ● ARBUTUS 2700

NEW YORK: Murray Hill 7-0926
BOSTON: Liberty 2-7917
CLEVELAND: Yellowstone 2-6107
HOUSTON: Blackstone 6388
MOBILE: Hemlock 2-4466
NEW ORLEANS: Raymond 9744
SAN FRANCISCO: Yukon 6-2803
SEATTLE: Main 8930

● ● ● ● ● ● ●
● ● ● ● ● ● ●
● ● *announcing–*

new openings ○ ● ●
at Rocketdyne's Field Laboratory

for **MECHANICAL ENGINEERS** **STRUCTURAL ENGINEERS** **ELECTRICAL ENGINEERS** **CHEMICAL ENGINEERS** **DESIGNERS** **DRAFTSMEN**

Now, more men with chemical plant or refinery experience are needed to work in Rocketdyne's expanding rocket engine test equipment R&D program.

The work is in fluid flow, high pressure piping, pressure vessels, heat exchangers, structural steel design, electro-mechanical controls and recording instrumentation.

○ **Contact: Mr. A. W. Jamieson, Rocketdyne Engineering Personnel, Dept. 596- PR , 6633 Canoga Avenue, Canoga Park, California.**

ROCKETDYNE
A DIVISION OF NORTH AMERICAN AVIATION, INC.
BUILDERS OF POWER FOR OUTER SPACE

Meetings

Purdue University, Lafayette, Ind., May 15-17.

American Gas Assn., chemical, engineering, and manufactured gas production conference, Benjamin Franklin Hotel, Philadelphia, May 16-18.

30th Engineering Industries Exposition, New York State Society of Professional Engineers, with annual meeting, Statler Hotel, New York, May 17-19.

National Society for Professional Engineers, annual, Ambassador Hotel, Atlantic City, May 23-26.

Western Petroleum Refiners Assn., regional, Toledo, Ohio, May 24-25.

4th Conference on Mass Spectrometry, ASTM Committee E-14, Netherlands Plaza Hotel, Cincinnati, May 27-June 2.

Chemical Institute of Canada, annual, Mt. Royal Hotel, Montreal, May 28-30.

11th Short Course in Gas Technology, Texas College of Arts & Industries, Kingsville, May 30-June 2.

JUNE

Society of Automotive Engineers, summer, Chalfonte-Haddon Hall, Atlantic City, June 3-8.

National Fire Protection Assn., annual, Statler Hotel, Boston, June 4-8.

American Society for Quality Control, annual, Palais du Commerce, Montreal, June 6-8.

Gordon Research Conference on Catalysis and Petroleum, Colby Junior College, New London, N.H., June 11-15.

Pennsylvania Grade Crude Assn., annual, Bradford, Pa., June 13.

American Society of Mechanical Engineers, semi-annual, Statler Hotel, Cleveland, June 17-21.

American Society for Testing Materials, annual with apparatus exhibit, Chalfonte-Haddon Hall, Atlantic City, June 17-22.

Western Petroleum Refiners Assn., regional technical-industrial relations, Broadview Hotel, Wichita, Kan., June 21-22.

American Institute of Electrical Engineers, summer and Pacific general meetings, San Francisco, June 25-29.

AUGUST

6th International Symposium on Combustion, Combustion Institute, Yale University, New Haven, Aug. 19-24.

SEPTEMBER

International Congress on Catalysis, Bellevue-Stratford, Philadelphia, Sept. 10-14.

Pacific Coast Gas Assn., annual, Coronado, Calif., Sept. 11-13.

Electrical Conference of the Petroleum Industry, American Institute of Electrical Engineers, Kansas City, Mo., Sept. 12-14.

National Petroleum Assn., annual, Traymore Hotel, Atlantic City, Sept. 12-14.

American Chemical Society, annual, Atlantic City, Sept. 16-21.

Instrument Society of America, annual Instrument-Automation Conference and Exhibit, New York, Sept. 17-21.

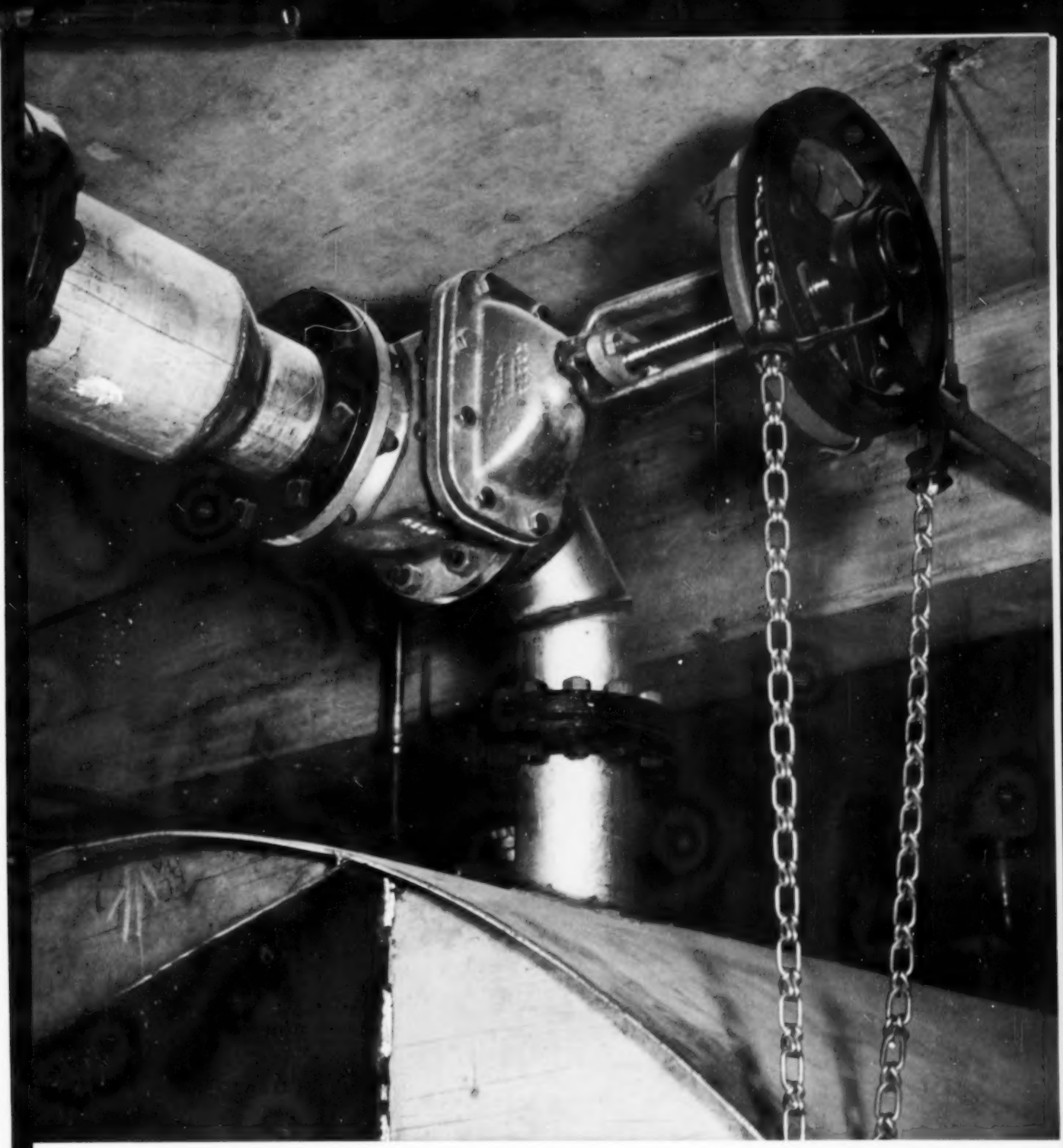
Western Petroleum Refiners Assn., regional technical-industrial relations meeting, Hotel Henning, Casper, Wyo., Sept. 20-21.

Petroleum Mechanical Engineering Conference, American Society of Mechanical Engineers, Statler-Hilton Hotel, Dallas, Sept. 23-26.

OCTOBER

American Gas Assn., annual, Atlantic City, Oct. 15-17.

(To obtain more data on advertised products see page 174)



Film censor at work

At 1500-acre Kodak Park, the film-producing plant of Eastman Kodak Co. in Rochester, N. Y., they take no chances on film contamination.

For example, in the operation shown here, a red-wheeled Alloyco stainless steel valve rules out of the picture dangerous rust and iron contaminants which would spoil the thick fluid which is called "dope."

These valves control the flow of dope onto roll-coating wheels, where solvents are driven off with heat. The dry film base is then readied for the final coat of emulsion.

Today thousands of industrial processes are being safeguarded by Alloyco corrosion and contaminant resistant valves. Find out why their dependable performance makes them first choice for all types of vital flow lines. Write Alloy Steel Products Co., Inc., 1301 West Elizabeth Avenue, Linden, N. J.

Longer Lasting
ALOYCO
VALVES
FOR IN-CORROSIVE SERVICE

Subsidiary of Walworth Company

Du Pont FOA-2

ashless stabilizer and dispersant for economy diesel fuels

Du Pont FOA-2 can help you make more economy grade diesel fuel from your existing stocks. This is possible because you can use FOA-2 to stabilize your cracked distillates and overcome the incompatibility between blends of cracked and straight-run stocks.

Good filterability

Since Du Pont FOA-2 is an excellent dispersant, it can be used in high temperature operation with excellent results in overcoming filter-plugging and injector-sticking problems. It's economical to use because it is effective in extremely low concentrations.

Ashless

Being nonmetallic and ashless, Du Pont FOA-2 does not contribute to the sparking tendency sometimes noted in connection with the exhaust systems of diesel locomotives.

In heating oils

The ashless feature of FOA-2 also offers advantages in heating oils. Since it leaves no deposits on burner electrodes it does not contribute to ignition failure. For the same reason, it does not interfere with the efficient operation of stack-controlling mechanisms.

Free samples and more detailed information on Du Pont FOA-2 are readily available from any of our sales offices listed below.

DU PONT

Reg. U.S. Pat. Off.

Better Things for Better Living
. . . through Chemistry

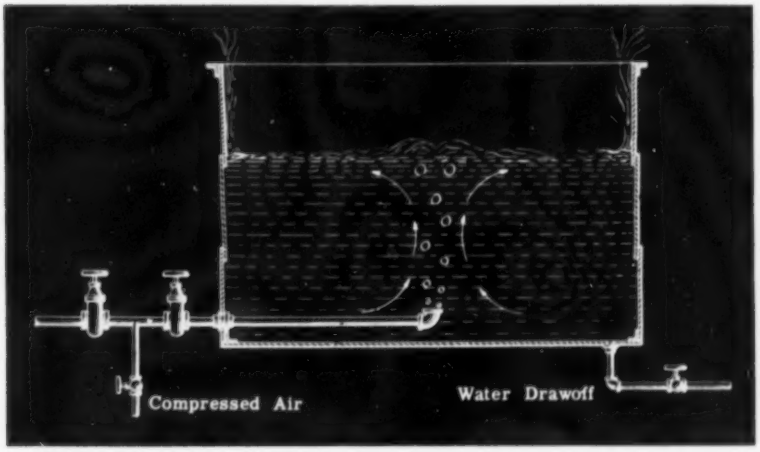
Petroleum Chemicals

Sales Offices: E. I. DU PONT DE NEMOURS & COMPANY (INC.) • *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

CHICAGO 3—8 So. Michigan Ave.	RAndolph 6-8630	PITTSBURGH 19—Room 510, Alcoa Bldg.	ATlantic 1-2933
HOUSTON 2—705 Bank of Commerce Bldg.	CApitol 5-1151	SAN FRANCISCO 4—Room 626, 111 Sutter St.	EXbrook 2-6230
LOS ANGELES 17—612 So. Flower St.	MAdison 5-1691	SEATTLE 3—Room 215, 4003 Aurora Ave.	MElrose 6977
NEW YORK 20—1270 Ave. of the Americas	COlumbus 5-2342	TULSA 1—P. O. Box 730	LUther 5-5578
PHILADELPHIA 2—3 Penn Center Plaza	LOcust 8-3531		

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals—85 Eglinton Avenue East—Toronto 12, Ontario—HUdson 1-6461
OTHER COUNTRIES: Petroleum Chemicals Division—Export Sales—Room 7496 Nemours Bldg.—Wilmington 98, Del.—OLympia 4-5121, Ext. 2962

By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.



FIRE IS EXTINGUISHED in an oil storage tank by piping in air to agitate the oil

Piping Air into Storage Tanks Used to Control Oil Fires

THE much-publicized method of putting out oil-tank fires announced by Socony Mobil Oil Co. has matured into Patent No. 2,730,178. This patent states that the most serious feature of oil tank fires is the "boil-over" caused by sudden vaporization of water at the bottom of the tank after the oil temperature has been raised sufficiently by the fire.

The invention is based on the fact that, to support combustion, the oil immediately adjacent to the burning surface must be at or above its flash point. The rest of the oil in the tank is not that hot and usually takes several hours to rise near the combustion-supporting level.

In the case of kerosene, the flash point usually is at least 125°F. The normal temperature of the body of kerosene in storage in a large tank is about the mean atmospheric temperature existing in the locality, usually not above 70-90°F. In a tank of kerosene burning at its surface, only an inch or so of the kerosene at the top is at the flash point until the tank has been burning for an hour or more. Hence, if the oil is agitated sufficiently to bring about mixing and cooling of the surface oil, it should be possible to stop combustion.

As shown in the illustration, this cooling is accomplished by blowing air through a deeply submerged pipe in the oil.

It is necessary to employ 6-13 cu. ft. of free air per minute per 100 sq. ft. of oil surface in order to effect this extinguishing action. Tests have indicated that, by use of this method, oil fires can be extinguished within one minute. Of course, with gasolines, naphthas and most crude oil the flash point is below the storage temperature, and the method provides only a form of control.

Add Strontium to Catalyst To Lower Coke Deposit

THE addition of 0.1% to 2% of strontium to silica-magnesia cracking catalysts has been found to improve cracking activity, particularly as regards coke production.

According to U. S. patent No. 2,731,397 issued to Sinclair Refining Co., the yield of useful products is improved by this means, and the regeneration burden is lessened. The presence of strontium directly improves regeneration by increasing the specific carbon burning rate in the combustion of adherent carbonaceous matter with an oxygen-containing gas.

Patents Issued Recently

The following listing gives the patent number, patentee, or assignee, and a brief description of patents of interest to the petroleum processing industries in the Official Gazette of the U.S. Patent Office for Feb. 21, 28, Mar. 6, and 13, 1956, Vol. 703 and 704, No. 3, 4, 1 and 2.

PROCESSES

Refining

2,734,592 (Universal Oil Products Co.) Separation of gases with permeable wall tubular member.
2,734,633 (Standard Oil Co. Ohio) Thermal diffusion method for separating liquids.
2,734,848 (Socony Mobil Oil Co.) Modified Duo-Sol refining.
2,734,849 (Texaco Development Corp.) Solvent dewaxing of petroleum oils.
2,735,755 (Phillips Petroleum Co.) Method of liquid-liquid contacting by directing stream of liquid droplets into rotating body.
2,735,843 (Phillips Petroleum Co.) Fractionation process, using urea.
2,735,878 (Socony Mobil Oil Co.) Separation of olefins from hydrocarbon mixtures by cuprous chloride and anhydrous HCl in methanol.
2,735,879 (Gulf Oil Corp.) Purification of unsaturated hydrocarbon gases by selectively hydrogenating acetylenic compounds.
2,735,880 (Phillips Petroleum Co.) Pebble heat exchanger and process.
2,736,667 (Socony Mobil Oil Co.) Deodorizing petroleum waxes with formaldehyde polymer.
2,736,688 (Lummus Co.) Method for distilling oils.
2,736,691 (Phillips Petroleum Co.) Separation of aromatic hydrocarbons by extractive distillation with phosphorous tribromide.
2,736,756 (Phillips Petroleum Co.) Recovery of ethylene.
2,737,450 (The Fluor Corp., Ltd.) Recovery of sulfur from waste hydrocarbon-containing sulfuric acid.
2,737,469 (Esso Research & Engineering Co.) Control of solvent extraction of lube oil fraction by passing raffinate through capacitance cell.
2,737,471 (Socony Mobil Oil Co.) Hydro-catalytic desulfurization of petroleum oils.
2,737,472 (Universal Oil Products Co.) Sweetening of hydrocarbon distillates with a phenylene diamine, a carboxylic acid salt of an amine and oxygen.
2,737,508 (Phillips Petroleum Co.) Separation of straight-chain compounds from branched-chain compounds, using urea.
2,737,538 (Phillips Petroleum Co.) 2-Pyrrolidone as a selective solvent for aromatic hydrocarbons.

Conversions

2,734,850 (Esso Research & Engineering Co.) Fluid coking of heavy hydrocarbons.
2,734,851 (Esso Research & Engineering Co.) Coke calcining process.
2,734,852 (Esso Research & Engineering Co.) Elutriating burner in fluid coking processes.
2,734,853 (Esso Research & Engineering Co.) Integrated coking and calcining process.
2,735,743 (Esso Research & Engineering Co.) Transfer of heat in fluidized solids systems.
2,735,802 (Esso Research & Engineering Co.) Method for controlling temperatures in fluidized solids systems for the conversion of hydrocarbons.
2,735,803 (Universal Oil Products Co.) Method for contacting subdivided solid particles with different fluid streams within separate superimposed contacting zones.
2,735,804 (Esso Research & Engineering Co.) Use of normally gaseous hydrocarbon for stripping of circulating coke in a fluidized coking process.
2,735,806 (Esso Research & Engineering Co.) Method of scouring equipment in a fluid

CLASSIFIED

Petroleum chemist

BEEN LOOKING for a position with lots of day-to-day variety and interest? The petroleum instrumentation section of the Fisher Development Laboratories is the place. Your assignment: to design and promote new items in a leading line of petroleum testing equipment and handle liaison with the ASTM.

Age: 30-40 . . . petroleum lab experience . . . familiarity with ASTM methods and apparatus . . . a flair for instrument design. Employee benefits are excellent; working conditions A-1.

Rush résumé (confidential), salary requirements, instrumentation background, to PAUL FAUPEL, PERSONNEL MGR., FISHER SCIENTIFIC, 711 FORBES ST., PITTSBURGH 19, PENNA.

ENGINEERS
for SOUTH AMERICA

Field Mechanical Engineers

Refinery experienced required.
Knowledge SPANISH helpful.
Call or send resume:
MR. GEORGE COUGHLIN

BECHTEL
Engineers-Constructors
5 West 45th St., N. Y. C.
PLAZA 7-4400, EXT. 38

PATENT ATTORNEY

Major Oil Company is seeking a patent lawyer with chemical background, and several years patent experience. If you are now earning in the neighborhood of $10,000, and are ready to step up, send a resume of your personal history, education and experience, in complete confidence, to Mr. H. M. Overley.

P.O. BOX 7250, Phila. 1, Pa.

SURPLUS CHEMICALS

We have closed down and are reclaiming for sale our Tallant, Oklahoma chemical plant where formaldehyde, acetaldehyde, methanol, and other chemicals were made.

Inventory available upon request.

CITIES SERVICE OIL
Patridge, Bartlesville, Oklahoma

Method of scouring equipment in a fluid coking process.

2,735,822 (Esso Research & Engineering Co.) Method of and apparatus for contacting solids and gases.

2,735,876 (The Texas Co.) Conversion of gaseous hydrocarbons into ethylene and aromatics by cracking in Ni-free chrome steel tubes.

2,735,877 (Sun Oil Co.) Hydrogenation of aromatic compounds with the use of molybdenum disulfide on a spent cracking catalyst.

2,736,684 (M. W. Kellogg Co.) Reforming process to produce 100/130 grade aviation gasoline, using Mo, Cr, Pt. catalyst.

2,736,685 (Esso Research & Engineering Co.) Process of petrolatum cracking in liquid and vapor phase.

2,736,687 (Esso Research & Engineering Co.) Shot heated fluid conversion system for fluid coking.

2,736,689 (Sun Oil Co.) Hydrogenation of unsaturated hydrocarbons employing a metal sulfide catalyst having a nitrogenous base chemisorbed thereon.

2,736,690 (Esso Research & Engineering Co.) Integrated process for coking, agglomerating and calcining hydrocarbon oil.

2,737,294 (Sun Oil Co.) Upper surface level control in a compact solids bed.

2,737,473 (Esso Research & Engineering Co.) Continuous fluidized bed hydroforming.

2,737,474 (Esso Research & Engineering Co.) Catalytic conversion of residual oils in dense fluidized bed.

2,737,475 (Esso Research & Engineering Co.) Conversion of heavy residual hydrocarbons in presence of fluidized coke particles.

2,737,477 (Esso Research & Engineering Co.) Hydroforming by cyclic process using PT catalyst.

2,737,478 (Socony Mobil Oil Co.) Hydrocarbon conversion process, using compact mass of particle-form solid contact material.

2,737,479 (Esso Research & Engineering Co.) Staged separation and stabilization of oil conversion products and apparatus therefor in curvilinear coking path.

2,737,499 (General Electric Co.) Organic-HF emulsions.

2,737,534 (Imperial Chemical Industries Ltd.) Production of aromatic hydrocarbons (p-xylene) from six carbon aliphatic diols, using Cr catalyst.

2,737,536 (Universal Oil Products Co.) Method of synthesizing tert-alkyl substituted aromatic compounds by alkylation.

2,737,537 (Imperial Chemical Industries Ltd.) Production of aromatic hydrocarbons by catalytic isomerization of 25 dimethylhex-3-yne-1:5 diene.

2,737,539 (Socony Mobil Oil Co.) Control of coking in thermal polymerization at above 1060°F. by limiting butenes to not over 6%.

Hydrocarbon Synthesis

2,735,862 (Esso Research & Engineering Co.) Synthesis of hydrocarbons with iron-cobalt catalyst.

2,737,448 (Chemical Construction Corp.) Continuous production of pure carbon monoxide from coke and oxygen.

PRODUCTS

Chemicals

2,734,566 (Phillips Petroleum Co.) Concentration of ammonium nitrate solutions.

2,734,870 (California Research Corp.) Non-soap synthetic detergent bar.

2,734,883 (Polymer Corp. Ltd.) Process for producing butadiene, styrene latices of improved stability.

2,734,884 (Esso Research & Engineering Co.) Alkyl esters and plastic compositions comprising same.

2,734,906 (Allied Chemical & Dye Corp.) Ethylene oxide production.

2,734,914 (Union Oil Co. of California) Production of terephthalic and isophthalic acids.

2,734,922 (Gulf Research & Development Co.) Hydroformylation of olefins.

2,734,923 (Esso Research & Engineering Co.) Preparation of naphthenic alcohols.

2,734,929 (Union Oil Co. of California) Dealkylation of hydrocarbons.

2,734,930 (California Research Corp.) Separation of ethylbenzene from crude xylene fractions.

2,735,829 (Shell Development Co.) Compositions containing a mixture of glycidyl polyethers of dihydric phenols.

2,735,832 (Phillips Petroleum Co.) Stable unsaturated organic-sulfur dioxide resins containing an ester of tetrathiophosphoric and trithionophosphorous acid and method of preparing.

2,735,835 (Phillips Petroleum Co.) Stable unsaturated organic-sulfur dioxide resins containing a salt of an ester of dithiophosphoric and method of preparing the same.

2,735,836 (Phillips Petroleum Co.) Unsaturated organic compound-sulfur dioxide resins stabilized with thiophosphoric acids and their derivatives.

2,735,871 (Shell Development Co.) Treatment of impure aralkyl hydroperoxides.

2,735,874 (The Texas Co.) Separation of fused polycyclic aromatic hydrocarbons and other compounds with tetrahalophthalic anhydride.

2,735,875 (Esso Research & Engineering Co.) Process for recovery of cycloalkadiene monomers from their dimers.

2,736,702 (Gulf Oil Corp.) Resinous condensation product (oil soluble) of formaldehyde, alkaline earth metal sulfide, and an alkylated monohydric phenol.

2,736,703 (Gulf Oil Corp.) Resinous products (oil soluble).

2,736,723 (Armstrong Cork Co.) Mercaptan-modified hydrocarbon polymers.

2,736,750 (Esso Research & Engineering Co.) Aldehyde synthesis process.

2,736,755 (Chemische Werke Huls A. G.) Process for recovering cyclohexane from the waste gas produced in the oxidation thereof.

2,737,480 (California Research Corp.) Recovery of acetone and phenol from cumene hydroperoxide decomposition product.

2,737,507 (Battelle Development Corp.) Selenol modification of synthetic rubberlike materials.

Catalysts

2,734,874 (Socony Mobil Oil Co.) Preparation of catalysts of vanadium oxide or chromium oxide on porous carriers.

2,735,744 (Esso Research & Engineering Co.) Method of and apparatus for controlling regenerator temperatures.

2,735,801 (Socony Mobil Oil Co.) Silica-alumina reforming catalyst supports and process for preparing the same.

2,736,713 (Universal Oil Products Co.) Method of dispersing inorganic oxide sols to produce spheres.

2,737,444 (Norton Co.) Aluminum oxide catalyst carrying material and process of making same.

2,737,476 (Esso Research & Engineering Co.) Method of regenerating hydroforming catalysts (Pt on alumina).

Fuels

2,734,808 (Du Pont Co.) p-Phenylenediamine gasoline stabilizers and compositions containing the same.

2,734,809-10 (Institute of Gas Technology) Method of making a fuel gas interchangeable with natural gas.

2,734,811 (Koppers Co.) Method for the production of fuel gas from liquid fuels by endothermic reaction with steam.

2,734,814 (Universal Oil Products Co.) Stabilization of heavier hydrocarbon distillates against sedimentation, using nitropyrimidine.

2,735,260 (F. A. Krauss-Maffei A. G.) Exhaust guiding means for preventing the formation of oil carbon deposits on the inner surface of the exhaust port in a two-cycle diesel engine.

2,735,265 (The Texas Co.) Process and apparatus for the generation of power from a solid carbonaceous fuel by superatmospheric combustion products working a gas turbine.

2,735,271 (Phillips Petroleum Co.) Dehydration of liquefied petroleum gas under pressure.

2,736,641 (Union Oil Co. of California) Fuel oil additive to inhibit separation of sludge (fatty acid amide of lower alkanolamine).

2,737,447 (General Electric Co.) Diborane preparation.

2,737,452 (Du Pont Co.) Fuel oils stabilized against sludging with olefine-amino copolymer.

Lubricants

2,734,862 (Esso Research & Engineering Co.) Synthetic casein fiber elastic grease.

2,734,863 (Esso Research & Engineering Co.) Phospho-sulfurized hydrocarbons.

2,734,864-6 (American Cyanamid Co.) Stabilized lubricating compositions containing dithiophosphate Ni, Al, Cd, etc.

2,734,867 (Esso Research & Engineering Co.) Additive for lubricants (reaction product of sulfur chloride with cyclohexenyl compound).

2,734,868 (The Texas Co.) Rock drill lubricant containing a phosphorus acid ester and a sulfurized fatty oil.

2,734,869 (Esso Research & Engineering Co.)

get cleaner

more economical liquid/vapor

SEPARATION

with "Schuylernit" Entrainment Separators

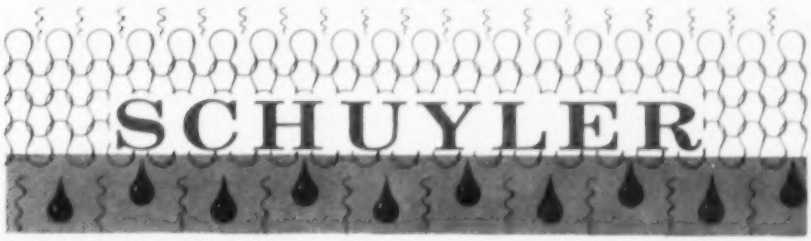
Stop costly liquid loss . . . in chemical and petroleum process equipment at lower cost with "Schuylernit" Entrainment Separators (mist eliminators). Specifically designed and constructed to separate liquid and small solid particles from any gas or vapor, "Schuylernit" Entrainment Separators assure these advantages: Elimination of liquid loss . . . increased throughput . . . improved process efficiency . . . reduced vessel sizes . . . reduced contamination . . . improved product quality.

- **"Schuylernit" Entrainment Separators are highly recommended for:** Vacuum and flash towers, gas absorbers, evaporators, distillation equipment, knock-out drums, steam drums, scrubbers, gas filters, compressors.

Immediate delivery on round, square or special shapes in any thickness for new or existing equipment. Send for illustrated Bulletin 203, Schuyler Manufacturing Corp., 81 Porete Avenue, North Arlington, New Jersey.

Copyright 1956 Schuyler Manufacturing Corp.

specialists in liquid/vapor separation



MANUFACTURING CORP., NO. ARLINGTON, N. J.

Lubricating oil additive (reaction product of sulfur chloride, ketone and sulfur).
2,735,814 (The Hodson Corp.) Die forging compound containing graphite, polyethylene glycol oleate, etc.
2,735,815 (Esso Research & Engineering Co.) Preparation of soap-salt grease complexes utilizing preformed acid salt.
2,735,816 (Robert L. Merker and William A. Zisman) Fluid compositions containing an orthosilicate.
2,735,817 (Esso Research & Engineering Co.) Stabilized lubricating oil additives (P-S-treated sulfurized sperm oil).
2,736,699 (United States Steel Corp.) Cold working lubricant for wire and the like, containing ferrous sulfate.
2,736,700 (United States of America) Lubricant (molybdenum disulfide-Zn O) for cold drawing of thorium wire.
2,736,701 (Union Oil Co. of California) Lubricating composition containing oil soluble complex.
2,736,704-5 (Gulf Oil Corp.) Detergent lubricating oils containing condensation product of alkyl phenol, aniline and CS_2.
2,736,706 (The Texas Co.) Lubricant containing a phosphorus acid ester-aldehyde condensation product.
2,736,707 (The Texas Co.) Lubricant containing phosphate partial ester-aldehyde-amine condensation product.
2,736,737 (The Texas Co.) Phosphate partial ester-aldehyde condensation product and lubricant containing the same.
2,736,738 (The Texas Co.) Phosphate partial ester-aldehyde-amine condensation product and lubricant containing the same.
2,737,492 (American Cyanamid Co.) Lubricating oil compositions stabilized against oxidation by metal coordination complexes.
2,737,493 (Socony Mobil Oil Co.) Lithium soap grease with phosphate ester vehicle.
2,737,494 (Socony Mobil Oil Co.) Stable greases containing synthetic gelling agents.
2,737,496 (Du Pont Co.) Lubricating oil compositions containing amino polymeric additives.

Specialties

2,734,827 (Southwestern Petroleum Co.) Fire-resistant asphalt with coating silica aerogel.
2,734,829 (California Research Corp.) Lead drier concentrate.
2,734,832 (Williams Brothers Co.) Method of internally coating pipes.
2,735,753 (Columbian Carbon Co.) Manufacture of carbon black.
2,735,754 (Standard Oil Co.-Ind.) Industrial corrosion testing and recording.
2,735,828 (Phillips Petroleum Co.) Recovery of carbon black.
2,736,658 (Armour and Co.) Method of protecting metal surfaces from corrosion and corrosion inhibitor compositions (polyamine reaction product in protective grease).
2,736,709 (General Aniline & Film Corp.) Hydraulic fluids containing alkaline buffering agent.
2,737,458 (Union Carbide and Carbon Corp.) Water repellent composition containing wax, fixative, etc.
2,737,479 (Esso Research & Engineering Co.) Manufacture of paraffin wax of improved stability by adding specialty treated scale wax.
2,737,491 (Cities Service Research & Development Co.) Method of inhibiting corrosion of metals using heterocyclic compound having O and N in nucleus.
2,737,495 (Standard Oil Co.-Ohio) Grinding oil containing pyrophosphatidic acid and sulfur.
2,737,497 (Esso Research & Engineering Co.) Non-flammable hydraulic fluid comprising thickened ethylene glycol.

Miscellaneous

2,735,624 (The Texas Co.) Pulverizing process, including forming a slurry of solid particles and a liquified normally gaseous refrigerant, vaporizing the liquid, and turbulently passing the vaporized dispersion through a zone in which there is high velocity and decreasing pressure.
2,735,787 (The Texas Co.) Process for pulverizing solid materials.
2,736,813 (Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint Gobain, Chauny & Cirey) Gas analysis for SO_2.

EQUIPMENT

Processing, general

2,735,482 (Hydrocarbon Research, Inc.) Burners for the production of synthetic gas.
2,735,744 (Esso Research & Engineering Co.) Apparatus and method for controlling regenerator temperatures.
2,735,880 (Phillips Petroleum Co.) Pebble heat exchanger and process.
2,736,533 (John L. Allen) Heat exchanger.
2,736,611 (Socony Mobil Oil Co.) Push type fluid conveyor.
2,736,686 (Phillips Petroleum Co.) Pebble heater reaction for conversion of hydrocarbons, with the use of inert solids.
2,737,159 (Chemical Construction Co.) Baffle and tube arrangement in catalytic reforming heater.
2,737,160 (Combustion Engineering, Inc.) Steam generators using radiant superheaters and reheaters.
2,737,258-9 (Koppers Co.) Electrical precipitator.
2,737,261 (Farr Co.) Multiple stage separator.
2,737,370 (Martin Frisch and John Blizard) Extended surface element for heat exchanger.
2,737,376 (Aktiebolaget Hedemora Verkstader) Contacting apparatus for gases or vapors and liquids.
2,737,377 (Koch Engineering Co.) Gas-liquid contact apparatus.
2,737,482 (Fernando Mario Mora) Rectifying tower for rectifying crude gaseous acetone and other fluids.
2,737,784 (Gesellschaft fur Linde's Eismaschinen A. G.) Apparatus for obtaining liquid oxygen.
2,737,930 (Babcock & Wilcox Co.) Vapor generating and superheating method and apparatus.
2,737,931 (Babcock & Wilcox Co.) Apparatus and method for controlling vapor temperatures.
2,738,026 (National Tank Co.) Low temperature separation process and unit.
2,738,123 (U.S.A.) Pressure exchanger with combined static and dynamic pressure exchange.
2,738,174 (Houilleres du Bassin du Nord et du

NEW···
an advanced concept in metering small flows

The Brooks Sho-Rate "50" is a new design idea in purge meters. It offers the complete interchangeability, dependability and structural strength that's been needed for a long time.

- Slip-out Tubes
- Side-plate Construction
- Rotatable End-fittings

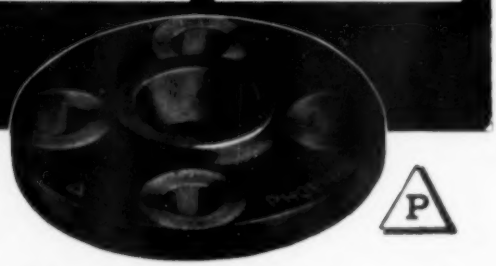
The Sho-Rate "50" Purge Meter gives all this at a very low cost. *Send for complete facts.*

BROOKS ROTAMETER COMPANY
107 EIGHTH STREET • LANSDALE, PA.

WRITE FOR BULLETIN 135

BROOKS and SHO-RATE are trade names

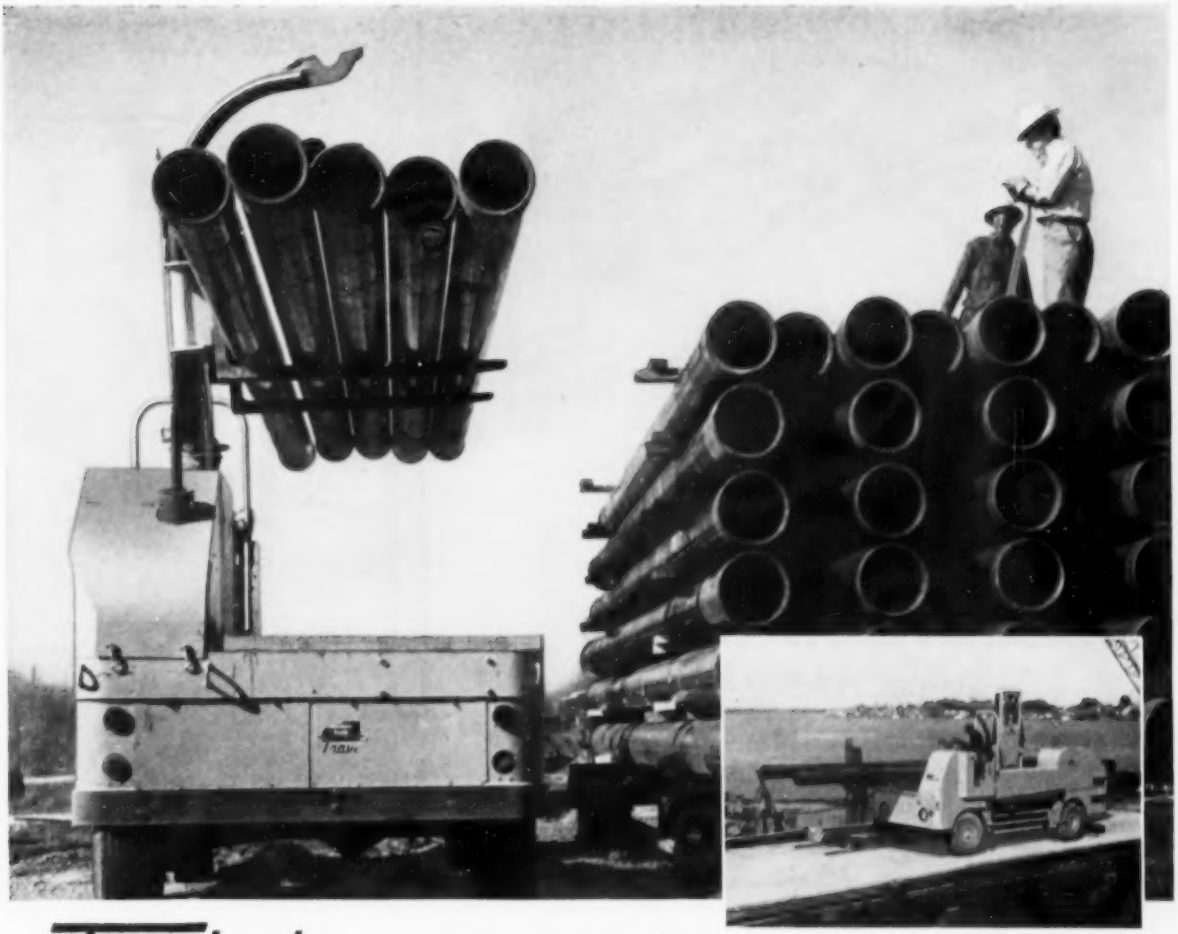
PHOENIX *Drop-Forged* FLANGES MEAN...
MAXIMUM STRENGTH



Long life is assured with Phoenix maximum strength flanges. Forged of mild steel, they are available in a wide range of styles and sizes. Meet ASA requirements and ASME and ASTM specifications.

NEW CATALOG!
Send for free brochure showing Phoenix Complete Line.

FLANGE DIVISION
PHOENIX MANUFACTURING CO.
Catasauqua, Pa. • Joliet, Ill.



Traveloader replaces 3 trucks and releases 6 men for other work!

● A Traveloader is used by Kyle-Taylor Lumber Company, Berwick, La., to transport pipe from river dock to storage. It has replaced two pipe trailers and a gin-pole truck formerly used on this job, reduced man-power required from 15 to 9 and made time savings of about 70%.

This company, serving oil producers, receives pipe in barges at the river dock. A truck crane unloads and places the pipe on the dock. The Traveloader picks it up five lengths at a time, transports it to the storage yard, and stacks it neatly on racks for further disposition.

Time studies reveal the speed with which Traveloader works. Loading time at dock averages 35 seconds. Hauling to storage, stacking and returning to dock (round trip .55 miles) averages 3 minutes 8 seconds. The stacking part of this operation takes only 24 seconds! As a result the crane at the dock never has to wait for the Traveloader.

Since the company operates 24 hours, 7 days per week, the cost savings are substantial. Moreover, 6 more workers were made available without increasing payroll, and two less mechanized units require maintenance. "This machine is by far the finest that I have seen for handling pipe. It has doubled our capacity with less labor," says Mr. J. E. Kyle, Jr., Vice President.

Write for Bulletin 1360. It completely describes the remarkable TRAVELOADER that carries like a straddle truck, delivers like a road truck, and stacks like a fork truck.

See Baker Trucks in action at the MHI Show, June 5-8

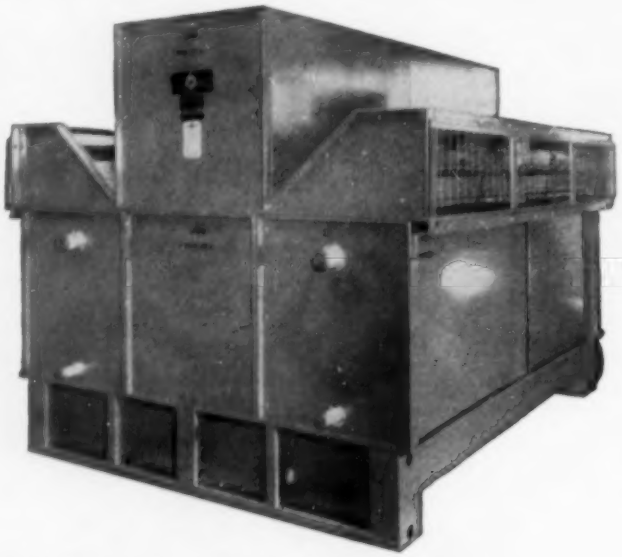
Baker handling equipment

THE BAKER-RAULANG COMPANY

1248 WEST 80th STREET • CLEVELAND 2, OHIO

A Subsidiary of Otis Elevator Company

672



NIAGARA SECTIONAL
***Aero* HEAT EXCHANGER**

gives close temperature control, saves you ***LABOR,*** *Power, Water*

- **Because the new design improves the heat transfer to the out-door air by evaporation.**
- **Because new features keep your equipment working for long life with "new plant" efficiency...always full capacity.**
- **Because you save 95% of cooling water cost.**

You get faster, more accurate cooling of industrial fluids to specified temperatures.

You improve your quality of production by removing heat at the rate of input.

You save labor in upkeep. With full access to all interior parts and piping you see everything in easy inspections. You head off dirt accumulation and corrosion. Casing panels are removable without moving the coils. The coils can be cleaned from both sides.

First cost is low; freight is low because of the lowest space/weight ratio; you save much labor in erection. Capacity range is 7,000,000 to 18,000,000 Btu/hr. No other heat exchange method gives you so much saving in money and convenience.

Write for Niagara Bulletin 132. Ask for the full story of how you can save expense in your plant and improve your product's quality.

NIAGARA BLOWER COMPANY
Dept. PP, 405 Lexington Avenue
NEW YORK 17, N. Y.
District Engineers in Principal Cities

NIAGARA — *Over 40 Years' Service in Industrial Air Engineering*

Pas-de-Calais) Reaction apparatus for continuous operation.
2,735,272 (Sporlan Valve Co.) Liquid level control devices.
2,735,300 (American Viscose Corp.) Flow indicator.
2,735,301 (Louis Schwob) High accuracy electric level indicator.
2,735,302 (Mackay C. Saylor) Liquid level indicator.
2,735,408 (Rockwell Manufacturing Co.) Fluid meter.
2,735,944 (Halliburton Oil Well Cementing Co.) Apparatus for determining density of fluids.
2,736,013 (Magnetrol, Inc.) Liquid level responsive mechanism.
2,736,190-1 (F. & M. Schaefer Brewing Co.) Testing device for determining volume of gas in liquid.
2,736,198 (Garrett Corp.) Fluid stream direction indicator.
2,736,199 (Negretti & Zambra Ltd.) Apparatus responsive to multiple fluid pressures.
2,736,201 (Shell Development Co.) Automatic metering and sampling station.
2,736,782 (U. S. Navy) Electrical indicator.
2,736,813 (Societe Anonyme des Manufactures des Glaces et Produits Chimiques de Saint Gobain) Gas analysis apparatus and method.
2,737,808 (S. Smith & Sons Ltd.) Liquid contents gage.
2,737,809 (Leeds and Northrup Co.) Double beam radiation pyrometer.
2,737,810 (Continental Oil Co.) Electrical resistance thermometer.
2,737,973 (Garman O. Kimmell) Liquid level control system.
2,738,398 (Allis-Chalmers Mfg. Co.) Perforated arc chute barrier plates for circuit interrupter.

Pumps and Compressors

2,735,369 (Universal Products Co.) Bellow pump.
2,735,372 (Plessey Co.) Gear pump or motor.
2,736,265 (Shellmaker, Inc.) Centrifugal pump.
2,736,266 (Thompson Products, Inc.) Pump impeller construction.
2,736,267 (Bruce Moshacher) Pump, motor or like device.
2,737,121 (Cambri Idraulici Badalini S.p.A.) Rotary pump.
2,737,341 (Trico Products Corp.) Rotary pump.
2,737,898 (Carl Andermatt and Vincent Gubeli) Centrifugal pump.
2,737,978 (Petrolite Corp.) Pumping apparatus.

Valves and Fittings

2,735,439 (Minneapolis-Honeywell Regulator Co.) Combined manual and safety valve.
2,735,443 (Clarence E. Beck) Automatic bidirectional flow valves.
2,735,444 (Mueller Co.) Fluid pressure regulator.
2,735,445 (General Controls) Relief valve.
2,735,447 (General Controls Co.) Valve structure.
2,735,448-9 (The Texas Co.) Pipe spacing device.
2,735,590 (Oil Equipment Laboratories) Combined closure and valve operating member.
2,735,642 (James E. Norman) Fluid flow regulating valve.
2,735,644 (Minneapolis-Honeywell Regulator Co.) Solenoid valve.
2,735,645 (Duriron Co.) Plug valve with plug retaining liner key.
2,736,286 (American Viscose Corp.) Pipe and flange aligner.
2,736,332 (Phillips Petroleum Co.) Fluid pressure equalizer.
2,736,333 (Burton W. Hancox) Low pressure sealing valves.
2,736,338 (Karl B. Britton) Check valve.
2,736,339 (Parker Appliance Co.) Rotary valve.
2,736,529 (General Electric Co.) Valve seat locking mechanism.
2,736,578 (Arthur W. Rafferty) Rotative sleeve lock swivel coupler.
2,737,200 (Merit Engineering, Inc.) Relief valve.
2,737,365 (Parker Appliance Co.) Gate valve.
2,737,979 (Esso Research & Engineering Co.) Mixing valve structure and method of operation.
2,738,151 (Carpenter and Paterson, Inc.) Pipe-supporting expansion rocker.

Miscellaneous

2,736,187 (Harbison-Walker Refractories Co.) Composite furnace block.
2,737,453 (Chicago Bridge & Iron Co.) Gas storage apparatus.
2,738,261 (Harry P. Townsend) Apparatus for mixing air and liquified petroleum gases.

It's Easy with UNICOR®

TO AVOID CONTAMINATION OF PIPE LINE PRODUCTS

You get complete freedom from product contamination and at the same time economical protection for your pipe line when you use UOP UNICOR.

UNICOR is added only at the points of product entry, is distributed uniformly over the entire internal surface and effects 100% protection.

UNICOR is inexpensive to use, too. Actually, only one or two molecules of UNICOR are required for every 1,000,000 molecules of gasoline. This makes UNICOR's cost only about $0.0005/bbl. of pipe line product. There are additional savings, too, in reduced scraper-cleaning and filter replacement costs.

Our technical staff will be glad to assist you in the design, installation and operation of a UNICOR system of protection. Write us for information and samples.

PRODUCTS DEPARTMENT

UNIVERSAL OIL PRODUCTS COMPANY

30 ALGONQUIN ROAD
DES PLAINES, ILLINOIS, U. S. A.

KING SIZE

This giant 37 ton Cat Poly Reactor is one of 4 units shipped to a large petroleum refinery in the State of Washington. It is 4'-3½" in diameter by 32'-0" long and has a 1 3/16" thick shell. Each of its 8" thick heads is attached to the shell channel with 28 special alloy stud bolts 2¾" diameter by 15¼" long having nuts 4¼" across the flats. Into the 5¾" thick tube sheets 190 tubes, 2½" O. D., No. 5 gauge and 30'-0" long, are rolled and seal welded. Designed for 1,230 lbs. pressure on the tube side, the reactor was completely X-rayed and stress relieved.

Vogt, a leading builder of shell and tube reactors for poly plants, has the competently skilled personnel and modern mechanical facilities with which to provide heat transfer equipment for the most exacting services in petroleum refineries, chemical plants, and related industries.

Reactors ...by Vogt

A bulletin describing the wide range of heat transfer equipment built by Vogt is available upon request.

Address Dept. 24-XPP

HENRY VOGT MACHINE CO., LOUISVILLE, KENTUCKY

BRANCH OFFICES: NEW YORK, CHICAGO, CLEVELAND, DALLAS, PHILADELPHIA, ST. LOUIS, CHARLESTON, W. VA.

Help for the Analytical Chemist

TWO new books on analytical chemistry, *New Methods in Analytical Chemistry* and *Advanced Analytical Chemistry*, serve to systematize previous knowledge, and present some previously unpublished material.

New Methods in Analytical Chemistry, by Ronald Belcher and Cecil L. Wilson, 1955, 5¾ x 8¾ in., 287 pages, indexed, stiff cloth cover, $5.50, Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y.

In *New Methods of Analytical Chemistry*, Belcher and Wilson present a compilation of new methods in the field of gravimetric and titrimetric analysis — employing classical techniques—which have been developed for the past 25 years. A large number of these techniques have not appeared in standard textbooks of analytical chemistry.

Consisting of 7 chapters, the book covers separation by precipitation and extraction, inorganic precipitants, organic reagents, indicators, titrants, and miscellaneous methods. The authors also include detailed discussions and descriptions of analytical methods and operational techniques, with factors contributing to time saving and accuracy.

A need long felt by research institutions and laboratories has been fulfilled by the authors, and should save literature survey time required by research chemists.

Advanced Analytical Chemistry, by Walter Wagner, Clarence J. Hull and Gerald E. Markel, 1956, 6¼ x 9½ in., 282 pages, indexed, illustrated, stiff cloth cover, $6.00, Reinhold Publishing Corp., 430 Park Ave., New York 22, N.Y.

A systematic review of many of the theoretical developments and instrumental methods, as well as a thorough description of the analysis of elements is given by the authors in *Advanced Analytical Chemistry*.

Part one of the book deals mainly with analytical techniques, while part two gives the analytical chemistry of the elements.

In general, all topics have detailed theoretical discussions and descriptions of methods and apparatus. Topics covered in the first part of the book include organic reagents (with specific treatment of reagents forming normal and chelated salts gas analysis (for O_2, O_3, CO_2, CO, H_2, CH_4, C_2H_2, Cl_2, NO_x, N_2, and some inert gases), colorimetry, turbidimetry, nephelometry, fluorometry, spectrophotometry, flame photometry, polarography, amperometric titrations, chromatography, ion exchange, thermogravimetric analysis (a recent development receiving a brilliant survey of investigations and a discussion of findings by the authors), and radiochemistry.

In the second part of the book, on the analysis of the elements, the authors describe the physical properties of each element, qualitative methods for the less familiar elements, and quantitative titrative methods of analysis and separation. Included are clear descriptions of physiochemical methods together with many references facilitating investigations concerning each element.

Reviewed by David Rothbard, New York City.

Recent Books Briefly Noted

Steam, Its Generation and Use, 37th ed., 1955, 8½ x 11 in., 632 pp., index, hard cloth cover, illustrated, $10.00, The Babcock & Wilcox Co., 161 E. 42nd St., New York 17, N. Y.

. . . intended primarily for mechanical engineers and students in the applied thermo field, prepared by engineers and specialists within the B&W Co.

World Petroleum Statistical Yearbook, 1954 ed., edited by Henry J. Struth, 8½ x 11 in., 455 pp., table of contents, hard cloth cover, $20.00, Palmer Publications, 604 Fifth Ave., New York 20, N. Y.

. . . gives statistics in details for the U. S., and for foreign nations on supply and demand, exploration and drilling, reserves, finding costs, refining, natural gasoline, carbon black, petrochemicals, marketing, imports and exports, prices, and consumption.

Information Processing Equipment, edited by M. P. Doss, 1955, 6 x 9 in., 270 pp., index, illustrated, $8.75, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . describes and illustrates latest methods of preparing, reproducing, utilizing and storing all types of technical information.

Everything and the Kitchen Sink, 1955, 8 x 11 in., 160 pp., illustrated, $4.00, Farrar Strau & Cudahy, Inc., available from The Philip Lesly Co., 424 Madison Ave., New York 17, N. Y.

. . . the industrial history of Chicago during the growth of the Crane Co.,—commemorating Crane's Centennial—profusely illustrated with drawings and photos.

Autohydrogenation of Oil Gases, IGT Research Bulletin No. 25, March, 1955, by H. A. Dirksen, H. R. Linden, E. S. Pettijohn, 8½ x 11 in., 76 pp., table of contents, illustrated, heavy paper cover, $5.00, Institute of Gas Technology, 17 W. 34th St., Technology Center, Chicago 16, Ill.

. . . results of a study sponsored by the American Gas Association to demonstrate the improvement autohydrogenation would make in the substitutability of oil gases for natural gas.

Research Reactors, 1955, prepared by the U. S. Atomic Energy Commission, 8½ x 10½ in., 442 pp., table of contents, illustrated, stiff cloth cover, $6.50, McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 36, N. Y.

. . . gives detailed descriptions of six representative types of U. S. research atomic reactors including three types of light-water-moderated reactors, one hydrocarbon-moderated reactor, one heavy-water-moderated reactor and one graphite-moderated reactor.

Fifth Symposium (International) on Combustion, 1955, published for the Combustion Institute under the auspices of the Standing Committee on Combustion Symposia, on meeting at University of Pittsburgh, Pittsburgh, Pa., Aug. 30-Sept. 3, 1954, 7 x 10¼ in., 802 pp., table of contents, illustrated, stiff cloth cover, $15.00, Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

. . . contains 101 papers by 182 contributors from many parts of the world discussing combustion problems involved in the efficient operation of all types of engines.

Supplement to: Statistics of Importance to Refiners, 1955, 8½x11 in., 22 loose-leaf pages for incorporation into existing notebook, no charge, Western Petroleum Refiners Assn., 1428 Hunt Bldg., Tulsa 3, Okla.

. . . has miscellaneous data on crude oil production and demand, runs to stills, refinery product demand, etc.

Bibliographic Survey of Corrosion 1950-1951, 1955, 8¾x11¼ in., 435 pp., indexed, stiff cloth cover, $10.00 to members of NACE or $12.50 to non-members, National Assn. of Corrosion Engrs., 1061 M & M Bldg., Houston 2, Texas.

. . . gives summaries of 4454 corrosion and corrosion prevention articles, books and brochures published in 1950-1951 with material from over 500 sources over the world.

Spontaneous Ignition of Liquid Fuels, 1955, B. P. Mullins, 6¼x10 in., 117 pp., indexed, illustrated, stiff cloth cover, $2.75, Interscience Publishers, Ind., 250 Fifth Ave., New York 1, N. Y.

. . . essentially a review and assessment of the state of knowledge in this one area of the combustion field.

(Continued on next page)

PROOF POSITIVE

foster MASTIC COATING RESISTS FIRE

Arc welding above freshly-applied Foster 60-60N (left) fails to ignite coating; while ordinary asphalt mastic (right) ignites and burns fiercely until consumed.

foster Fire-Resistive Mastic 60-60N is:

Non-flammable during (and after) application by spray or trowel—no danger of ignition from welding sparks or splatter.

Fire-resistive when dry, won't add fuel to accidental fire exposure. (Foster 60-60 is still the only weather-coating listed by Underwriters' Laboratories).*

An effective barrier to moisture vapor; a requirement for coating low temperature thermal insulations, (vapor permeance 0.02 perm).

Outstanding for protecting steel and thermal insulation from weather and chemicals (both liquid spillage and atmospheric fumes);

Unparalleled by any conventional mastic coating for retained flexibility under prolonged heat and sunlight.

A companion product, Foster's Fire-Resistive Mastic 60-60 is listed and inspected by the Underwriters' Laboratories, Inc.

Underwriters' Laboratories, Inc. INSPECTED WEATHER PROTECTIVE COATING

foster FIRE RESISTIVE MASTIC 60-60

*Dry film of 60-60N is identical with dry film of 60-60. 60-60N is an improved mastic made with non-flammable, non-toxic volatile solvent.

BENJAMIN foster COMPANY

4635-37 W. Girard Avenue

PHILADELPHIA 31, PA.

Distribution and Technical Services available in principal U. S. and Canadian Industrial Areas.

YOUR ORGANIZATION

Is it complete?

Are you expanding it?

Making Replacements?

Naturally, you are anxious to secure the most suitable man or men available. You want men with the special training that will make them an asset to your organization. You can contact such men through an advertisement in the Classified Section of Petroleum Processing. For information write:

PETROLEUM PROCESSING

330 West 42nd Street **New York 36, New York**

Books

ASTM Standards on Plastics (D-20), 1955, 6x9 in., 790 pp., table of contents, illustrated, paper cover, $5.75, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

. . . presents ASTM standards and tentative specifications, methods of analysis, methods of physical testing, recommended practices and definitions of terms which are pertinent to plastics.

Engineering Standards — Multiple V-Belt Drives, 1955, 8½x11 in., 24 pp., illustrated, paper cover, $1.00 from either Rubber Manufacturers' Assn., Inc., 444 Madison Ave., New York 22, N. Y., or Multiple V-Belt Drive & Mechanical Power Transmission Assn., 27 E. Monroe St., Chicago 3, Ill.

. . . indicates proper sheaves and belts to be used for the attainment of optimum efficiency and economy of the drive with relation to the particular duty to be performed.

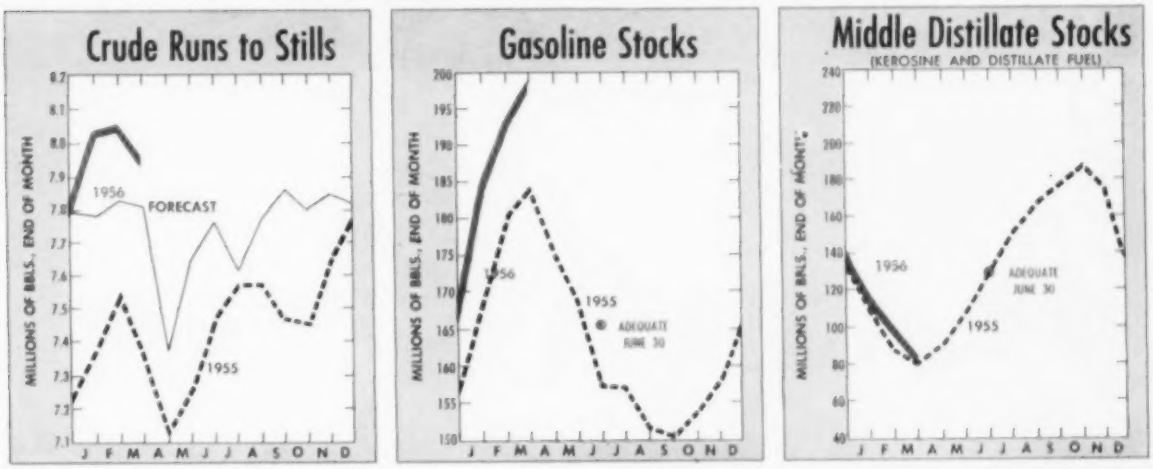
1955 Book of ASTM Standards: Part 1— Ferrous Metals, 1955, 6x9 in., 1834 pp., table of contents, illustrated, cloth cover, $13.50, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

. . . has 315 standards with 125 that are new or revised since 1954.

Physical-Chemical Properties of Ethane-Nitrogen Mixtures, Institute of Gas Technology Research Bulletin 26, 1955, by B. E. Eakin, R. T. Ellington and D. C. Gami, 8½x11 in., 40 pp., table of contents, illustrated, $5.00, Institute of Gas Technology, 17 W. 34th St., Technology Center, Chicago 16, Ill.

. . . completes the Institute's series of studies of the physical-chemical properties of binary mixtures of methane, ethane and nitrogen started in 1952.

"If I ever strike it rich, I'm gonna buy an old abandoned refinery and smoke whenever I darn well please!"


Crude Runs to Stills
MILLIONS OF BBLS., END OF MONTH
1956
FORECAST
1955
J F M A M J J A S O N D
Gasoline Stocks
MILLIONS OF BBLS., END OF MONTH
1956
1955
ADEQUATE JUNE 30
J F M A M J J A S O N D
Middle Distillate Stocks
(KEROSINE AND DISTILLATE FUEL)
MILLIONS OF BBLS., END OF MONTH
1956
1955
ADEQUATE JUNE 30
J F M A M J J A S O N D

1956 figures to March 30

Gamble on Big Summer Gasoline Sales

OUTLOOK: Heavy drafts on gasoline stocks will bring them to between 165-170,000,000 bbls. by June 30, but still several million bbls. above the 1955 level.

REFINERY operations continue to be geared to an anticipated record gasoline demand during the coming summer, and discount the fact that overall gasoline inventories Mar. 30 were 12,900,000 bbls. higher than their peak last spring of 185,282,000 bbls.

Crude runs in the first quarter averaged 7,989,000 b/d avg., over 7% greater than actual runs in the first quarter of 1955, and nearly 3% larger than the volume forecast as required to meet product demand requirements. Average daily first quarter runs were 382,000 bbls. daily higher than the 7,607,000 b/d forecast runs for the second quarter.

Indicated gasoline demand at refineries in the first quarter was nearly 6% higher than in the same period in 1955, and second quarter demand is expected to continue at a high rate of gain over the 1955 second quarter. However, this may not be a true indicator of gasoline demand for the last half of 1956. Several factors, including touring and the earlier starting of vacation periods, tend to build up refinery withdrawals in the late spring.

Demand in the second quarter of 1955 was very close to the third quarter in actual volume, and the rate of gain over 1954 sales was larger in the second than in the third quarter. If this relationship continues this year, the current high rate of demand may ease off in the last six months.

Overall gasoline inventories March 30, 198,209,000 bbls., were 21,609,000 bbls. over the 176,600,000 bbls., the average of estimates of 19 oil companies made to The Texas Railroad Commission as a desirable gasoline stock level on April 1.

Middle distillates' supply-demand followed the normal pattern for the first quarter, and stocks (kerosine and distillate fuel oils combined) of around 129,000,000 bbls. are indicated for June 30.

MARCH KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	Mar. 1956*	Feb. 1956	Mar. 1955
CRUDE OIL			
U. S. Production	7.156	7.114	6.886
Imports	.857	.822	.742
U. S. Stocks	262.066	256.962	264.430
Runs to Stills	7.920	8.045	7.374
GASOLINE			
Refinery Output	3.713	3.726	3.460
Refinery Demand	3.688	3.374	3.486
Primary Stocks	198.209	194.473	183.972
MIDDLE DISTILLATES			
Refinery Output	2.175	2.319	2.060
Refinery Demand	2.546	2.879	2.249
Primary Stocks	79.916	90.999	80.644
RESIDUALS			
Refinery Output	1.226	1.286	1.186
Imports	.443	.558	.517
Total Supply	1.683	1.858	1.724
Refinery Demand	1.783	1.912	1.749
Primary Stocks	33.896	36.907	44.970

*Through March 30.

PRODUCT AND CRUDE PRICES

(Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$/bbl., principal fields
Source—Platt's Oilgram Price Service)

	Mar. 1956*	Feb. 1956	Mar. 1955
Gasoline (regular)	11.63	11.70	11.21
Distillate Fuel Oil	9.53	9.53	9.31
Kerosine	11.02	10.98	10.69
Residuals	5.18	5.14	4.23
Above 4 Products	9.35	9.37	8.81
Lube Oils	22.27	21.99	16.82
Crude	2.84	2.83	2.82

REFINERY YIELDS

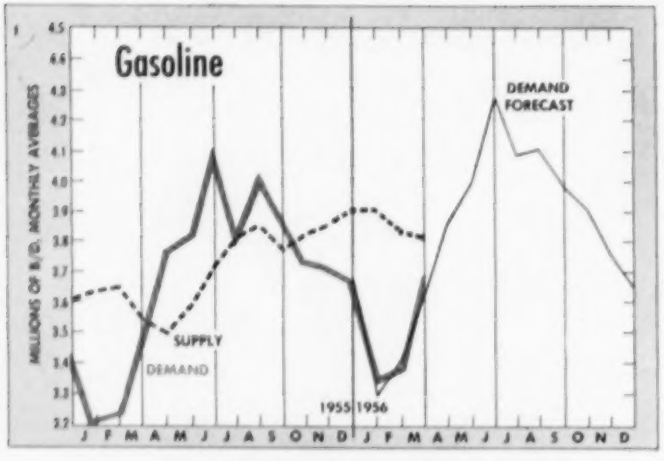
% on Crude Runs to Stills

	Mar. 1956*	Feb. 1956	Mar. 1955
Gasoline	42.6	42.1	42.4
Kerosine	4.5	4.7	4.8
Distillate	23.0	24.1	23.0
Residuals	15.5	16.0	16.0

*Through March 30.

SOURCE OF DATA (except prices): Feb. and Mar., API weekly reports; earlier months, Bureau of Mines

Strong Spring Demand for Gasoline Indicated

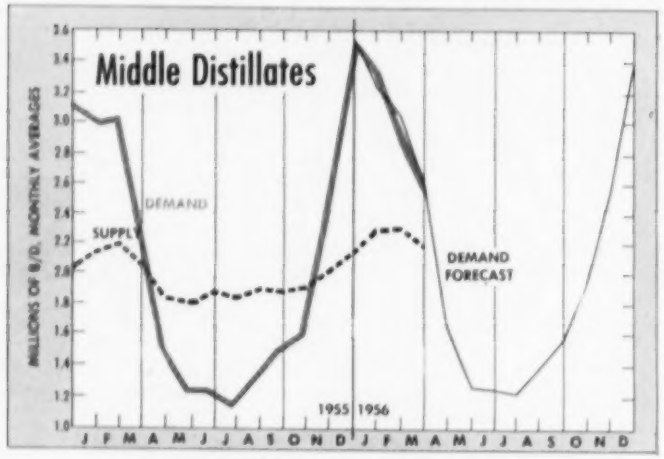


1956 figures to March 30

MOTOR FUELS

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Mar. '56	3.375	.438	3.813
Mar. '55	3.136	.407	3.543
Change	+ .239	+ .031	+ .270
% Change	+ 7.6	+ 7.6	+ 7.6
DEMAND (including Exports) (Millions of b/d)			
Mar. '56			3.688
Mar. '55			3.486
Change			+ .202
% Change			+ 5.8
TOTAL SUPPLY (Millions of bbls.)			
3 Mos. '56	311.211	39.969	351.180
3 Mos. '55	287.050	37.938	324.988
Change	+ 24.161	+ 2.031	+ 26.192
% Change	+ 8.4	+ 5.4	8.0
TOTAL DEMAND (including Exports) (Millions of bbls)			
3 Mos. '56			315.569
3 Mos. '55			297.831
Change			+ 17.738
% Change			+ 5.9

Distillate Demand Follows the Forecast Pattern

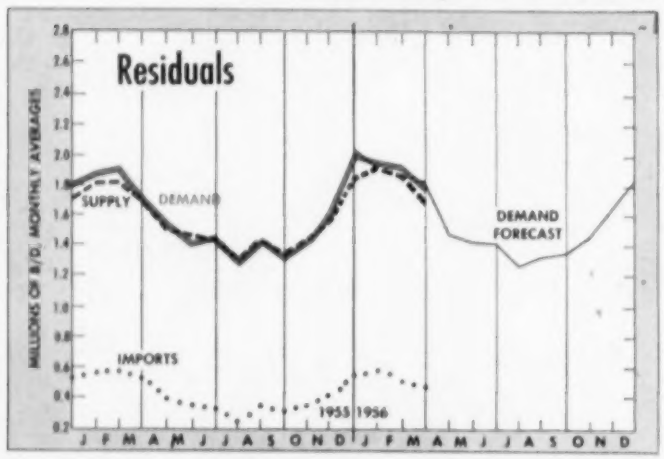

Middle Distillates
MILLIONS OF B/D, MONTHLY AVERAGES
DEMAND
SUPPLY
DEMAND FORECAST
1955 1956
J F M A M J J A S O N D J F M A M J J A S O N D

1956 figures to March 30

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
Mar. '56	.355	1.820	2.175
Mar. '55	.357	1.703	2.060
Change	— .002	+ .117	+ .115
% Change	0.5	6.9	+ 5.6
DEMAND (including Exports) (Millions of b/d)			
Mar. '56	.397	2.148	2.545
Mar. '55	.361	1.936	2.297
Change	+ .036	+ .212	+ .248
% Change	+ 10.0	+ 11.0	+ 10.8
TOTAL PRODUCTION (Millions of bbls.)			
3 Mos. '56	33.958	172.267	206.225
3 Mos. '55	34.216	158.424	192.640
Change	— .258	+ 13.843	+ 13.585
% Change	— 0.8	+ 8.7	+ 7.1
TOTAL DEMAND (including Exports) (Millions of bbls.)			
3 Mos. '56	43.292	222.164	265.456
3 Mos. '55	43.855	205.366	249.221
Change	— .563	+ 16.798	+ 16.235
% Change	— 1.3	+ 8.2	+ 6.5

Seasonal Drop in Residual Fuel Withdrawals


Residuals
MILLIONS OF B/D, MONTHLY AVERAGES
SUPPLY
DEMAND
DEMAND FORECAST
IMPORTS
1955 1956
J F M A M J J A S O N D J F M A M J J A S O N D

1956 figures to March 30

RESIDUAL FUELS

	Refinery Output	Imports	Total
SUPPLY (Million of b/d)			
Mar. '56	1.240	.443	1.683
Mar. '55	1.185	.517	1.702
Change	+ .055	— .074	— .019
% Change	+ 4.6	— 14.3	— 1.1
DEMAND (including Exports) (Millions of b/d)			
Mar. '56			1.783
Mar. '55			1.749
Change			+ .034
% Change			+ 1.9
TOTAL SUPPLY (Millions of bbls.)			
3 Mos. '56	117.814	48.185	165.999
3 Mos. '55	109.681	50.075	159.756
Change	+ 8.133	— 1.890	+ 6.243
% Change	+ 7.4	— 3.8	+ 3.9
TOTAL DEMAND (including Exports) (Millions of bbls.)			
3 Mos. '56			172.090
3 Mos. '55			168.142
Change			+ 3.948
% Change			+ 2.3

1956 figures to March 30
SOURCE OF DATA: Feb. and Mar., API weekly reports; earlier months, Bureau of Mines

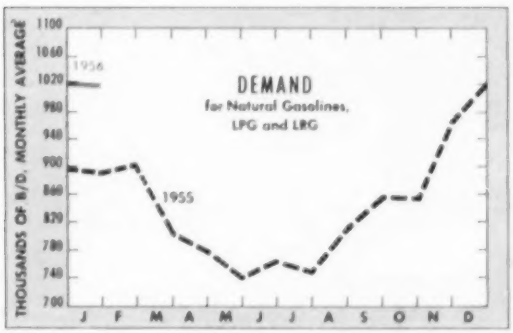
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U.S. REFINERY DISTRICTS

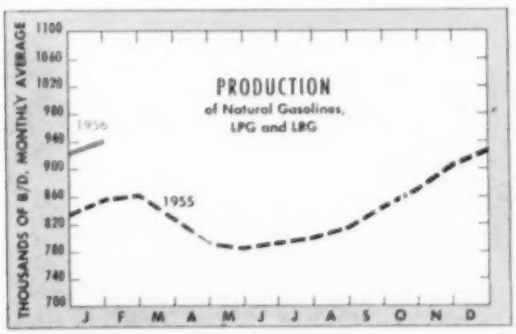
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Mar. 30 1956	Apr. 1 1955	Change	% Change	GASOLINE STOCKS (Millions of bbls. on date shown) Mar. 30 1956	Apr. 1 1955	Change	% Change	RESIDUAL STOCKS (Millions of bbls. on date shown) Mar. 30 1956	Apr. 1 1955	Change	% Change
East Coast	1.135	1.073	+ .062	+ 5.8	40.770	37.964	+ 2.806	+ 7.4	9.117	8.332	+ .785	+ 9.4
Gulf Coast	2.645	2.443	+ .202	+ 8.3	38.039	36.502	+ 1.537	+ 4.2	6.602	5.432	+ 1.170	+21.5
Total Coastal	3.780	3.516	+ .264	+ 7.5	78.809	74.466	+ 4.343	+ 5.8	15.719	13.764	+ 1.955	+14.2
Appalachian	.203	.175	+ .028	+16.0	7.842	7.705	+ .137	+ 1.8	.607	.410	+ .197	+48.0
Ind.-Ill.-Ky.	1.366	1.262	+ .104	+ 8.2	41.879	40.935	+ .944	+ 2.3	3.513	2.998	+ .515	+17.2
Okla.-Kans.-Mo.	.622	.598	+ .024	+ 4.0	22.836	20.380	+ 2.456	+12.1	1.014	.869	+ .145	+16.7
Other Inland	.597	.590	+ .007	+ 1.2	20.984	20.200	+ .784	+ 3.9	2.319	2.141	+ .178	+ 8.3
Total Inland	2.788	2.625	+ .163	+ 6.2	93.541	89.220	+ 4.321	+ 4.8	7.453	6.418	+ 1.035	+16.1
Total East of Calif.	6.568	6.141	+ .427	+ 6.9	172.350	163.686	+ 8.664	+ 5.3	23.172	20.182	+ 2.990	+14.9
California	1.126	1.065	+ .061	+ 5.7	25.859	21.596	+ 4.263	+19.7	10.724	24.452	−13.728	−56.1
Total U.S.	7.694	7.206	+ .488	+ 6.8	198.209	185.282	+12.927	+ 7.0	33.896	44.634	−10.738	−24.1

District	DISTILLATE FUEL OIL STOCKS (Millions of bbls. on date shown) Mar. 30 1956	Apr. 1 1955	Change	% Change	KEROSINE STOCKS (Millions of bbls. on date shown) Mar. 30 1956	Apr. 1 1955	Change	% Change	TOTAL MIDDLE DISTILLATE STOCKS (Millions of bbls. on date shown) Mar. 30 1956	Apr. 1 1955	Change	% Change
East Coast	19.608	22.462	− 2.854	−12.7	7.093	8.157	− 1.064	−13.0	26.701	30.619	− 3.918	−12.8
Gulf Coast	12.161	8.670	+ 3.491	+40.0	4.116	3.128	+ .988	+31.6	16.277	11.798	+ 4.479	+38.0
Total Coastal	31.769	31.132	+ .637	+ 2.0	11.209	11.285	− .076	− 0.7	42.978	42.417	+ .561	+ 1.3
Appalachian	1.755	2.069	− .314	−15.2	.792	.822	− .030	− 3.6	2.547	2.891	− .344	−11.9
Ind.-Ill.-Ky.	9.937	9.572	+ .365	+ 3.8	3.212	4.064	− .852	−21.0	13.149	13.636	− .487	− 3.6
Okla.-Kans.-Mo.	6.974	6.144	+ .830	+13.5	.693	.906	− .213	−23.5	7.667	7.050	+ .617	+ 8.8
Other Inland	4.479	4.227	+ .252	+ 6.0	1.084	1.218	− .134	−11.0	5.563	5.445	+ .118	+ 2.2
Total Inland	23.145	22.012	+ 1.133	+ 5.1	5.781	7.010	− 1.229	−17.5	28.926	29.022	− .096	− 0.3
Total East of Calif.	54.914	53.144	+ 1.770	+ 3.3	16.990	18.295	− 1.305	− 7.1	71.904	71.439	+ .465	+ 0.7
California	7.669	8.706	− 1.037	−11.9	.343	.325	+ .018	+ 5.5	8.012	9.031	− 1.019	−11.3
Total U.S.	62.583	61.850	+ .733	+ 1.1	17.333	18.620	− 1.287	− 6.9	79.916	80.470	− .554	− 0.7

Natural Gas and Refinery Gas Liquids





SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	Jan. 1956	Dec. 1955	Jan. 1955
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	432	434	387
Natural Gasoline and Isopentane	277	271	267
Condensate	24	23	23
Finished Gasoline, Naphtha and Other	69	69	69
Total Natural Gasoline and Cycling Plant Production	802	797	746
Liquefied Refinery Gases	145	134	114
Total Marketable Gas Liquids	947	931	860
Lease Condensate	126	122	110
Total Natural Gas Liquids	1,073	1,053	970
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	663	674	536
Natural Gasoline, Isopentane and Other	357	354	347
Total Marketable Gas Liquids	1,020	1,028	883

CUMULATIVE PRODUCTION (1000 bbls.)	Jan. 1956	Jan. 1955
LPG and LRG	17,911	15,514
Natural Gasoline, Isopentane and Other	11,459	11,134
Total Marketable Gas Liquids	29,370	26,648
CUMULATIVE DEMAND (1000 bbls.)		
LPG and LRG	20,578	16,626
Natural Gasoline, Isopentane and Other	11,055	10,738
Total Marketable Gas Liquids	31,633	27,364

STOCKS (1000 bbls., end of month)	Jan. 1956	Dec. 1955	Jan. 1955
LPG and LRG	5,071	7,738	6,647
Natural Gasoline, Isopentane and Other	4,888	4,484	5,052
Total Stocks	9,959	12,222	11,699

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

ADDITIVES, lube oil, information on request; Oronite Chemical Co. See adv't. pp. 28A-28D.

ADDITIVES, fuel oil, data sheets; National Aluminate Corp. See adv't. p. 60A.

ANALYZER, for process streams, Mass spectrometer, bulletin CEC 1824A-X32; Consolidated Electrodynamics Corp. See adv't. p. 48.

ANALYZER, for light hydrocarbons, booklet 82; The Burrell Corp. See adv't. p. 200.

BARIUM CHEMICALS, for detergent lube oil additives, booklet; Westvaco Mineral Products. See adv't. p. 153.

CATALYTIC REFORMING, "Catforming," brochure; Atlantic Refining Co. See adv't. p. 130.

CATALYSTS, preformed, booklet; Harshaw Chemical Co. See adv't. p. 1.

CORROSION INHIBITOR, for pipe line products, information and samples; Universal Oil Products Co. See adv't. p. 165.

DRYING EQUIPMENT, for gases, molecular sieves, data sheets; Linde Air Products Co. See adv't. p. 17.

EXPANSION JOINTS, bulletin 351; Zallea Brothers. See adv't. p. 29.

EXPANSION JOINTS, catalog; Solar Aircraft Co. See adv't. p. 28.

FITTINGS, "Swagelok," catalog; Crawford Fitting Co. See adv't. p. 134.

FLANGES, drop forged, catalog; Phoenix Mfg. Co. See adv't. p. 162.

FLOW METERING, for small flows, bulletin 135; Brooks Rotameter Co. See adv't. p. 162.

FLUID CONTROL, systems, remote control, bulletins F1-56 & J-56; Hetherington & Berner, Inc. See adv't. p. 190.

FURFURAL, for solvent extraction, bulletin 203; Quaker Oats Co. See adv't. p. 205.

GASKETS, for corrosive service, "Teflon," booklet; Crane Packing Co. See adv't. p. 19.

GRADIATION HEATERS, bulletin 95; Selas Corp. of America. See adv't. p. 195.

HEAT EXCHANGERS, evaporative, bulletin 132; Niagara Blower Co. See adv't. p. 164.

HEAT TRANSFER EQUIPMENT, bulletin; Henry Vogt Machine Co. See adv't. p. 166.

HOSE, rubber, for petroleum products, booklet; Boston Woven Hose Co. See adv't. pp. 50-51.

INSULATION, industrial, for piping, snaps on, brochure; Gustin-Bacon Mfg. Co. See adv't. p. 148.

INSULATION, industrial, pipe and block, folder; Philip Carey Mfg. Co. See adv't. p. 137.

INSULATION, weatherproof mastic, brochure; American Bitumuls & Asphalt Co. See adv't. p. 192.

LABORATORY FURNACE, combustion units, bulletin 1001; Lindberg Engineering Co. See adv't. p. 196.

MATERIALS HANDLING, pipe handling truck, bulletin 1360; Baker-Raulang Co. See adv't. p. 163.

METERING, blending and mixing equipment, catalogs; Bowser, Inc. See adv't. p. 200.

MIXERS, and mechanical seals, catalogs and data sheets; Mixing Equipment Co. See adv't. p. 64.

MOTOR STARTERS, for hazardous locations, booklet 1062; Electric Controller & Mfg. Co. See adv't. p. 186.

OCTANES, economics of, booklet; The Ethyl Corp. See adv't. pp. 4-5.

PACKING, for use on equipment handling hot oil, gasoline, etc., catalog 54; U. S. Gasket—Belmont Packing. See adv't. p. 194.

PAINT STRIPPER, special report B-2415 and handbook F-7893; Oakite Products, Inc. See adv't. p. 156.

PIPE, valves and fittings, Saran lined; Dow Chemical Co. See adv't. p. 61.

PRESSURE TRANSMITTER, catalog 50-30; Fischer & Porter Co. See adv't. p. 18.

PRESSURE VESSELS, and process equipment, booklet; Newport News Shipbuilding & Drydock Co. See adv't. p. 197.

PUMPS, rotary, stainless steel, bulletin VP561; Cooper Alloy Corp. See adv't. p. 182.

SCAFFOLDING, prefab, steel frame, bulletins PTS-18, PSS-34 & J-9(M); Patent Scaffolding Co., Inc. See adv't. p. 144.

STEAM TRAPS, impulse type, bulletin EJ-1913; Yarnall-Waring Co. See adv't. p. 132.

STEAM TRAPS, new catalog 10-55; W. H. Nicholson & Co. See adv't. p. 147.

TUBE CUTTING, and expanding tools, literature; Airetool Mfg. Co. See adv't. p. 184.

TUBE, duplex, for heat exchangers, bulletin; Bridgeport Brass Co. See adv't. p. 135.

TURBINES, steam, governor controlled, catalog 500; Dean-Hill Pump Co. See adv't. p. 183.

TURBINES, compressor drive, high speed, bulletin 1966; Worthington Corp. See adv't. pp. 58-59.

TEMPERATURE CONTROLLER, transmitter, bulletin 13-19; Foxboro Co. See adv't. pp. 24-25.

THERMOMETERS, dial, bulletin 148; Manning, Maxwell & Moore, Inc. See adv't. p. 193.

VALVES, control, catalog 1500-C; Annin Co. See adv't. p. 203.

MOTORISTS GET ALL THE POWER THEY PAY FOR WHEN GASOLINE CONTAINS

Tenamene

EASTMAN GASOLINE ADDITIVES

The formation of gums can play havoc with the performance you've so carefully built into your gasoline. Play havoc with sales, too. Let Tenamene gum inhibitors solve this problem for you—Eastman's highly qualified petroleum specialists will be glad to visit your refinery and recommend the proper additive for your needs.

For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to EASTMAN CHEMICAL PRODUCTS, INC., *subsidiary of Eastman Kodak Company,* KINGSPORT, TENNESSEE.

SALES OFFICES: Eastman Chemical Products, Inc., Kingsport, Tennessee; New York City; Framingham, Mass.; Cincinnati; Cleveland; Chicago; St. Louis; Houston. **West Coast: Wilson Meyer Co.,** San Francisco; Los Angeles; Portland; Salt Lake City; Seattle.

FOR INFORMATION ON ANY PRODUCT OR SERVICE IN THIS ISSUE SEE INSTRUCTIONS BELOW

Each advertiser listed in this index has been assigned a code letter for use by the reader in securing additional information about advertised products, or services which interest him. This code letter appears in parantheses following the advertiser's name.

Circle the code letter on the "Advertised Product Inquiry" card (on the page opposite) which corresponds to that assigned the advertiser about whose product you want further information.

Fill in your name, title, company and mailing address and mail the card . . . no postage is required.

The Petroleum Processing Reader Service Department will give your inquiries prompt and efficient handling.

ADVERTISERS' INDEX

A

Air Preheater Corp. (G-9) 138
Air Products, Inc. (C-4) 32
Airetool Mfg. Co. (L-4) 184
Alloy Steel Products Co., Inc. (J-6) 158A
American Bitumuls & Asphalt Co. (M-5) 192
American Cyanamid Co., Refinery Chem. Dept. (M-4) 191
American Floor Surfacing Mach. (L-6) 185
American Petroleum Institute H-2) 143
Anaconda Co. (L-1) 181
Annin Co. (N-8) 203
Atlantic Refining Co. (G-1) 130

B

Babcock & Wilcox Co., Tubular Products Div. (J-4) 157
Baker-Raulang Co. (K-2) 163
Betz, W. H. & L. D. (H-8) 151
Bingham Pump Co. (B-5) 21
Boston Woven Hose & Rubber Co. (E-2) 50-51
Bowser, Inc. (N-4) 200
Bridgeport Brass Co. (G-6) 135
Brooks Rotameter Co. (J-9) 162
Burrell Corp. (N-5) 200

C

Carey Mfg. Co., Philip (G-8) 137
Catawissa Valve & Fittings Co. (N-2) 198
Chicago Bridge & Iron Co. (D-2) 41
Condenser Service & Engr. Co. (N-9) 204
Consolidated Electro-dynamics Corp. (D-9) 48
Cooper Alloy Corp. (L-2) 182
Cooper-Bessemer Corp. (L-8) 187
Crane Co. (F-9) 126
Crane Packing Co. (B-3) 19
Crawford Fitting Co. (G-5) 134

D

Dean Hill Pump Co. (L-3) 183
DeZurik Shower Co. (H-4) 146
Dow Chemical Co. (F-2) 61
Dowell, Inc. (N-3) 199
DuPont de Nemours & Co. (D-5) 44A-44B
DuPont de Nemours & Co. (J-7) 158B

E

Eastman Chemical Prods., Inc. (K-8) 173
Electric Controller & Mfg. Co. (L-7) 186
Enjay Co. (D-1) 40
Ernst Water Column & Gage Co. (J-1) 152
Ethyl Corp. (A-3) 4-5

F

Farris Engineering Corp. (C-3) 30-31
Fischer & Porter Co. (B-2) 18
Foster Co., Benjamin (K-7) 168
Foster Wheeler Corp. (C-6) 34-35
Foxboro Co. (B-7) 24-25

G

Gas Atmospheres, Inc. (H-9) 152
General American Trans. Corp., Plate & Welding Div. (A-4) 6
General American Trans. Corp., Terminals Div. (A-5) 8
General Chemical Div., Allied Chem. & Dye Corp. (O-2) Cover 3
General Refractories Co. (D-8) 47
Graver Tank & Mfg. Co. (A-9) 14
Gustin-Bacon Mfg. Co. (H-6) 148

H

Hammond Iron Works (F-7) 122-123
Harshaw Chemical Co. (A-2) 1
Hercules Powder Co. (A-7) 11
Hetherington & Berner, Inc. (M-3) 190
Hills-McCanna Co. (G-2) 131
Houdry Process Corp. (B-6) 22-23
Hudson Engineering Corp. (A-1) Cover 2

I

Indiana Commercial Filters Corp. (D-4) 44
International Nickel Co. (K-9) 179

J

Johns-Manville Corp., Insulation Div. (E-8) 60

K

Kellogg Co., M. W. (C-5) 33

L

Lindberg Engineering Co. (M-9) 196
Linde Air Products Co. (B-1) 17
Lukens Steel Co. (M-1) 189
Lummus Co. (A-8) 13

M

Manning, Maxwell & Moore, Inc. (M-6) 193
Maywood Chemical Works (M-2) 190
McKee Co., Arthur G. (E-1) 49
Mexico Refractories Co. (F-6) 121
Mixing Equipment Co. (F-5) 64

N

National Airoil Burner Co. (H-7) 150
National Aluminate Corp. (E-9) 60A
Newport News Shipbuilding & Drydock Co. (N-1) 197
Niagara Blower Co. (K-4) 164
Nicholson & Co., W. H. (H-5) 147
Nitrogen Div., Allied Chem. & Dye Corp. (F-8) 124
Norton Co. (D-3) 42-43

O

Oakite Products, Inc (J-3) 156
Olin-Mathieson Chemical Corp. (E-5) 56
Oronite Chemical Co. (C-1) 28A-28D
Owens-Corning Fiberglas Corp. (D-6) 45

P

Patent Chemicals, Inc. (C-8) 38
Patent Scaffolding Co., Inc. (H-3) 144
Patterson Foundry & Mach. Co. (G-7) 136
Petreco (E-6) 57
Petro-Chem. Development Co. (E-3) 52-53
Phoenix Mfg. Co. (K-1) 162
Powell Co., William (N-6) 201
Procon, Inc. (D-7) 46

Q

Quaker Oats Co. (O-1) 205

R

Refinery Engineering Co. (C-9) 39
Rhodia Inc., Alamask Div. (L-9) 188
Ridge Tool Co. (N-7) 202
Rocketdyne, Div. North American Aviation 158
Rockwell-Nordstrom Valves (B-8) 26-27

S

Schuyler Mfg. Co. (J-8) 161
Selas Corp. of America (M-8) 195
Socony Mobil Oil Co., Inc. (B-4) 20
Solar Aircraft Co. (B-9) 28

T

Taylor Instrument Cos. (C-7) 36-37
Tennessee Corp. (L-5) 185
Tretolite (F-1) 60B

U

U. S. Gasket-Belmont Packing (M-7) 194
U. S. Steel Corp. (F-3) 62
Universal Oil Products Co. (E-4) 54-55
Universal Oil Products Co., Products Dept. (K-5) 165

V

Vogt Machine Co., Henry (K-6) 166

W

Warren Petroleum Corp. (F-4) 63
Washington Aluminum Co., Inc. (J-5) 158
Westvaco Mineral Products (J-2) 153
Wolverine Tube, Div. Calumet & Hecla, Inc. (G-4) 132A-132B
Worthington Corp (E-7) 58-59
Wyatt Metal & Boiler Works (O-3) Cover 4

Y

Yarnell-Waring Co. (G-3) 132
York Co., Otto H. (H-1) 140

Z

Zallea Brothers (C-2) 29

CLASSIFIED ADVERTISING
F. J. Eberle, Business Mgr.

EMPLOYMENT OPPORTUNITIES 160
EQUIPMENT (Used or Surplus New) For Sale 160

This index is published as a convenience. Every care is taken to make it accurate, but PETROLEUM PROCESSING assumes no responsibility for errors or omissions.

You can use these handy Reader Service Cards for

- (A) More details on What's New
- (B) Information from Advertisers
- (C) Reprints of Editorial Articles
- (D) New or Renewal Subscriptions

A Are You Up-to-Date on What's New?

. . . get the **latest** details on the **newest** in—

- Equipment and materials
- Services
- Helpful literature

Read the reviews in the **What's New** section on the following pages, pick out the items that interest you, then circle the corresponding number in Area **"A"** on the **Reader Service Card.**

B More on Advertised Products

. . . do you want to know more about products or services advertised in this issue of PETROLEUM PROCESSING, or get copies of the literature offered in the ads? Refer to the **Advertisers' Index** on the preceding page for key numbers to circle in Area **"B"** on the **Reader Service Card.**

C Special Reprints Available

. . . do you need reprints of PETROLEUM PROCESSING's special reports, articles or **Data Sheets?** If so, see the other side of this sheet for order numbers and prices, then use Area **"C"** on the **Reader Service Card** to order them. We'll bill you later.

D Are You a "Pass-on" Reader?

. . . get your own personal copy of PETROLEUM PROCESSING promptly every month at low rates. Just check your choice in Area **"D"** on the **Reader Service Card**—we'll send your bill later, after you start getting your copies.

READER SERVICE CARD

A WHAT'S NEW ITEMS *Circle proper number*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

B ADVERTISED PRODUCTS *See Index on facing page*

A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	L1	M1	N1	O1	P1	Q1	S1	T1	U1	V1
A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	O2	P2	Q2	S2	T2	U2	V2
A3	B3	C3	D3	E3	F3	G3	H3	J3	K3	L3	M3	N3	O3	P3	Q3	S3	T3	U3	V3
A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	O4	P4	Q4	S4	T4	U4	V4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	O5	P5	Q5	S5	T5	U5	V5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	O6	P6	Q6	S6	T6	U6	V6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	O7	P7	Q7	S7	T7	U7	V7
A8	B8	C8	D8	E8	F8	G8	H8	J8	K8	L8	M8	N8	O8	P8	Q8	S8	T8	U8	V8
A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	O9	P9	Q9	S9	T9	U9	V9

C REPRINTS AVAILABLE *See listing on next page*

R1	R4	R7	R10	R13	R16	R19	R22	R25	R28	R31	R34	R37	R40	R43	R46
R2	R5	R8	R11	R14	R17	R20	R23	R26	R29	R32	R35	R38	R41	R44	R47
R3	R6	R9	R12	R15	R18	R21	R24	R27	R30	R33	R36	R39	R42	R45	R48

D NEW OR RENEWAL SUBSCRIPTION

New ☐ Renewal ☐ 1 year—$2.00 ☐ 2 years—$3.00 ☐ 3 years—$4.00 ☐

Petroleum Processing

For Issue of May, 1956 (Good until August 15, 1956)

Name (please print) _____

Position _____

Company _____

Business Address _____

City _____ Zone _____ State _____

FIRST CLASS PERMIT NO. 64 (Sec. 34.9 P. L. & R.) New York, N. Y.

BUSINESS REPLY CARD
No Postage Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY

PETROLEUM PROCESSING
330 WEST 42nd STREET
NEW YORK 36, N. Y.

FIRST CLASS
PERMIT NO. 64
(Sec. 34.9 P. L. & R.)
New York, N. Y.

BUSINESS REPLY CARD
No Postage Necessary if Mailed in the United States

4c-POSTAGE WILL BE PAID BY

PETROLEUM PROCESSING
330 WEST 42nd STREET
NEW YORK 36, N. Y.

READER SERVICE CARD

A WHAT'S NEW ITEMS *Circle proper number*

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60
61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80
81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	100

B ADVERTISED PRODUCTS *See index two pages back*

A1	B1	C1	D1	E1	F1	G1	H1	J1	K1	L1	M1	N1	O1	P1	Q1	S1	T1	U1	V1
A2	B2	C2	D2	E2	F2	G2	H2	J2	K2	L2	M2	N2	O2	P2	Q2	S2	T2	U2	V2
A3	B3	C3	D3	E3	F3	G3	H3	J3	K3	L3	M3	N3	O3	P3	Q3	S3	T3	U3	V3
A4	B4	C4	D4	E4	F4	G4	H4	J4	K4	L4	M4	N4	O4	P4	Q4	S4	T4	U4	V4
A5	B5	C5	D5	E5	F5	G5	H5	J5	K5	L5	M5	N5	O5	P5	Q5	S5	T5	U5	V5
A6	B6	C6	D6	E6	F6	G6	H6	J6	K6	L6	M6	N6	O6	P6	Q6	S6	T6	U6	V6
A7	B7	C7	D7	E7	F7	G7	H7	J7	K7	L7	M7	N7	O7	P7	Q7	S7	T7	U7	V7
A8	B8	C8	D8	E8	F8	G8	H8	J8	K8	L8	M8	N8	O8	P8	Q8	S8	T8	U8	V8
A9	B9	C9	D9	E9	F9	G9	H9	J9	K9	L9	M9	N9	O9	P9	Q9	S9	T9	U9	V9

C REPRINTS AVAILABLE *See listing*

R1	R4	R7	R10	R13	R16	R19	R22	R25	R28	R31	R34	R37	R40	R43	R46
R2	R5	R8	R11	R14	R17	R20	R23	R26	R29	R32	R35	R38	R41	R44	R47
R3	R6	R9	R12	R15	R18	R21	R24	R27	R30	R33	R36	R39	R42	R45	R48

D NEW OR RENEWAL SUBSCRIPTION

New ☐ Renewal ☐ 1 year—$2.00 ☐ 2 years—$3.00 ☐ 3 years—$4.00 ☐

Petroleum Processing

For Issue of May, 1956 (Good until August 15, 1956)

Name *(please print)* _____

Position _____

Company _____

Business Address _____

City _____ Zone ____ State ____

You can use these handy **Reader Service Cards** for

- (A) More details on What's New
- (B) Information from Advertisers
- (C) Reprints of Editorial Articles
- (D) New or Renewal Subscriptions

PETROLEUM PROCESSING Reprints

Need more copies of the following reprints? If so, check the numbers of items wanted and circle them on Area **"C"** of the **Reader Service Card.** We'll fill your order right away, and send you a bill.

• **Optimum Bubble-Cap Tray Design**—4-part article by W. L. Bolles of Monsanto Chemical Co. presents new concepts and easy-to-use working charts for the process design of bubble-cap trays. 51 pages —$1.50: Circle **R15.**

• **The Heat Exchanger**—covering process and mechanical design, cost estimating factors, types of construction, etc. 32 pages—$1.00: Circle **R8.**

• **Vaporization Equilibrium Constant and Activity Coefficient Charts**—for conditions up to system critical point. 48 pages—$1.50: Circle **R1.**

• **Catalytic Reforming Survey**—with trends, theory and processes for catalytic reforming and aromatics recovery. 48 pages—$0.75: Circle **R3.**

• **Clip·n·File Sheets**—$0.20 each, any 6 for $1.00. Process Data Sheets **(PDS's)** are 3-page fold-outs with flow diagram, process description, conditions and economics. Engineering Data Sheets **(EDS's)** are two pages on special heavy paper to allow repeated handling and reference use.

PDS No. 1, **Ethylene Oxide** Circle **R4**
PDS No. 2, **Butadiene·Butenes** Circle **R5**
PDS No. 3, **L'Azote Ammonia** Circle **R6**
PDS No. 4, **Ethylene—Kellogg** Circle **R9**
PDS No. 5, **Fluid Coking** Circle **R10**
PDS No. 6, **Chemico Urea** Circle **R-16**

EDS No. 1, **Pressure Fundamentals** Circle **R7**
EDS No. 2, **Temperature Fundamentals** Circle **R11**
EDS No. 3, **Fluid Flow Fundamentals** Circle **R-13**
EDS No. 4, **Flow Restrictions in Pipe** Circle **R14**
EDS No. 5, **Tank Capacities** Circle **R17**

Prices for quantity orders furnished on request.

WHAT'S NEW...

Ceramic Rope

Resists 2300°F Furnace Temperatures

Fiberfrax, an aluminum-silicate ceramic fiber, is now available in rope form for high temperature caulking and expansion joint packing.

As a result of its long staple, which is combined with 15% of a carrier-type fiber, the rope is resilient as well as light weight. Thirty feet of the rope (½-in. in diameter) weigh 1 lb., giving 50% more rope length than an equivalent weight of asbestos rope. The aluminum-silicate material is chemically inert and unaffected by most furnace atmospheres, including hydrogen.

Easily handled, the rope can be used for insulator wrapping, high temperature gaskets and seals, and as a high temperature joint packing. Supplied in coils with a maximum length of 800 ft., the rope is made in typical three-strand form. It is planned to produce the ceramic rope in diameters ranging from ¼ to ¾ in. **Carborundum Co.,** Niagara Falls, N.Y.

Circle No. **1** *on Reply Card*

Ozone Suppressor

. . . will prevent the deteriorating effect of ozone on rubber hose, gaskets, tires and other products.

Announced as its second rubber antiozidant, Universal Oil Products Co.'s "UOP 288" can be used in rubber goods that may be subjected to relatively high temperatures. The new compound may be used in synthetic rubbers, such as GR-S and oil-extended GR-S, which suffer more severe surface cracks from atmosphere ozone than does natural rubber. **Universal Oil Products Co.,** Des Plaines, Ill.

Circle No. **2** *on Reply Card*

Two-Stage Canned Pump

. . . handles corrosive, toxic, explosive and radio-active liquids without leaking.

Available in cast iron, cast steel, 300-series stainless steel Monel and Carpenter-20, the pump can be piped with the two chambers in series (as shown) or in parallel for high head or high volume pumping. The overall size of the pump is less than 2 x 1 x 1½ ft. and creates heads to 230 feet. Standard operating limits are 450°F and 300 psi. **Chempump Corp.,** 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. **3** *on Reply Card*

Shut-Off Valve

. . . features only one moving part, and operates on a pilot control pressure equal to the working pressure.

Perry Model AV-100 (shown above) is for one inch tubing, weighs 1 lb., and handles a flow of 50 gal./min. at a 50 psi pressure drop. Maximum working pressure of the valve is 3000 psig. Special stainless steel construction is available for highly corrosive fluids. **Perry Valve Corp.,** P. O. Box 132, Dover, N.J.

Circle No. **4** *on Reply Card*

(Continued on next page)

Push Button Spectrophotometer

Invades the Quality Control Lab

Designed for easy operation by a technician, after setup by a qualified operator, the new Beckman infrared spectrophotometer allows successive analysis of many samples. All the technician must do is insert the samples, push the START button, tear off the completed record, and change the sample for the next run.

This new instrument has many special features which permit simple but extremely accurate infrared analysis. The double monochromator provides twice the dispersion and twice the ultimate resolution and four times the scanning speed for the same resolution.

The recorder is mounted so that the chart paper travels horizontally, and it is not necessary to load a separate sheet of paper for each run. As each run is completed the instrument automatically realigns the chart paper and eliminates possibility of measurement errors caused by paper misalignment. The scanning speed can be changed at any time, even while recording.

The monochromator, interchange unit, and the mirror and prism mounts are made of meehanite, the most stable material available. Other structural parts are made of stabilized cast aluminum. Eight removable plug-in chassis mount the 30 required vacuum tubes. Required power is 500 watts, 115 volts, 60 cycles. Wavelength expansions available are: 0.4, 0.8, 1,2,2.5, 4, 5 and 10 in./micron. **Beckman Instruments, Inc.,** Fullerton, Calif.

Circle No. **5** *on Reply Card*

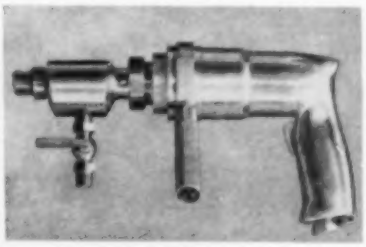
"High Priced" Paint

. . . **uses fluorinated resins** to protect surfaces from fuming nitric acid and other highly concentrated acids and alkalies.

Announced by its maker as "the highest-priced paint in the world" ($36 to $40/gal.), it can be brushed or sprayed like ordinary paint. It will air-dry in a few minutes. After drying overnight it has unusual resistance to corrosion from many agents, including severe oxidizing agents.

The new paint is claimed to have good adhesion to all types of metal surfaces, and excellent adhesion to wood or masonry. It will not support combustion and has a tensile strength of 4500-5500 psi. Outdoor durability is claimed excellent, and the paint is good for constant dry heat service up to 325°F. Lankote Fluor-B is available from the **Lankote Division, J. Landau Co.,** Washington Ave., Carlstadt, New Jersey.

Circle No. **6** *on Reply Card*



Tube Cleaner

. . . **operates on air** and is equipped with a built-in governor and oil reservoir.

Built with a gun-like grip and trigger valve, the new tool comes in two sizes. Both use a ⅜ in. hose with a ¼ in. thread. Air requirements are 15 to 20 cfm of air at 90 psig. Both tools also are equipped with a water-feed valve and a non-rotating water-feeding attachment. On the smaller model the water inlet hose connection is used as a second handle. **Lagonda Division, Elliot Co.,** Springfield, Ohio.

Circle No. **7** *on Reply Card*

Insulation Block

. . . **will withstand temperatures** up to 2300°F, is lightweight and chemically inert.

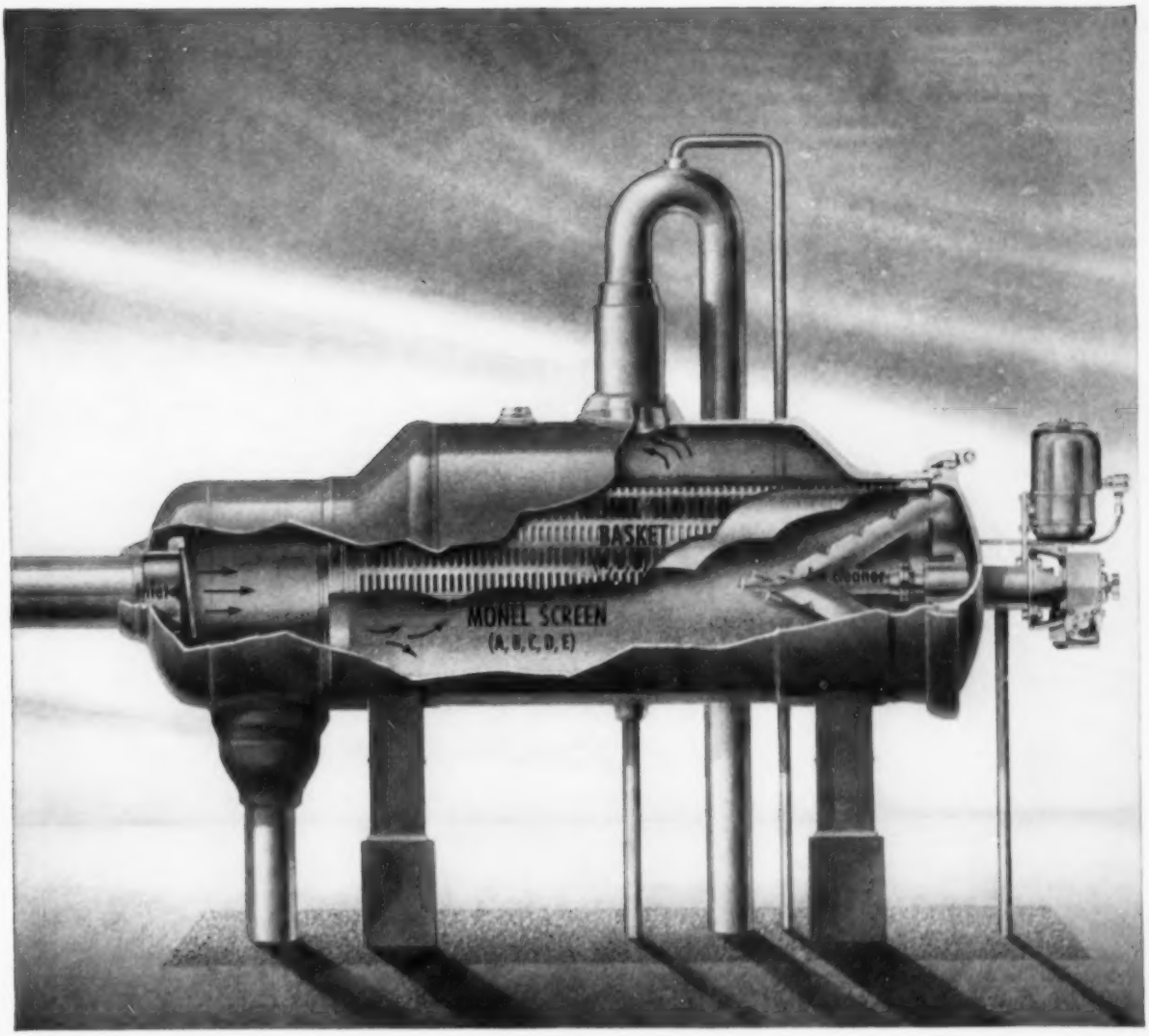
Made of bonded Fiberfrax ceramic fiber, the new insulation block is unaffected by furnace atmospheres or flame impingement. With an approximate density of 20 lbs./cu.ft., the block has a thermal conductivity of 1.27 Btu/hr.,sq.ft. and °F/in. of thickness at a mean temperature of 1000°F. At 2000°F the thermal conductivity is 2.24.

Greater compressive strength is gained by the greater density. The block's modulus of rupture is 48 psi, although when required, treatment with an organic compound will give the block a harder skin and boost the modulus of rupture to 69 psi.

Standard sizes are 12 x 12, 12 x 18, 6 x 18, 6 x 36, and 12 x 36 in. Thicknesses range from 1½ to 4-in. in ½-in. increments. **Carborundum Co.,** Niagara Falls, N.Y.

Circle No. **8** *on Reply Card*

(Continued on page 180)



How Monel improves the Thornhill-Craver strainer

A. Resists corrosives in refined products lines

B. Retains shape under high pressures

C. Withstands erosive attack by fast-moving gas-bubbles or moisture particles

D. Resists wear by entrained solids

E. Aids slough-off of gummy filtrate

Unique Thornhill-Craver horizontal strainer filters streams pressured to 400 psi. Jet cleaned without dismantling, manually (5 minutes, one man) or automatically. Details from Thornhill-Craver Company, Inc., P.O. Box 1184, Houston 1, Texas.

With Monel* nickel-copper alloy, the Thornhill-Craver strainer is better able to withstand the corrosives found in today's refinery products and intermediates.

Recent inspections revealed no deterioration of Monel parts after 4½ years.

Monel and other Inco Nickel alloys are used in thousands of locations and many different types of drilling, production and refining equipment. *They have proven uniquely resistant to corrosion, and well able to meet a wide range of severe physical requirements.* For assistance in their application, contact Inco's Development and Research Division.

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N. Y.

INCO NICKEL ALLOYS

*Registered trademark

 (To obtain more data on advertised products see page 174)

Mobile Radio "Mike"

. . . **uses transistors** to improve microphone output. Replacing the conventional carbon microphone, the new unit eliminates the need for preamplification at the transmitter and its attendant noise pickup. Instead, a specially designed dynamic element works with a built-in transistor preamplifier in the microphone to boost the output to conventional transmitter input level. The power for the amplifier is drawn from the conventional "talking current" supply.

The new mike is also available as a dual purpose "speaker-mike" (shown above) which can operate as a loudspeaker as well as a mike. Held near the ear it overcomes high ambient noise. This dual purpose mike-and-speaker uses the same dynamic unit and transistor amplifier as the microphone. **Motorola Communications and Electronics Inc.,** 4501 W. Augusta Blvd., Chicago 51, Ill.

Circle No. **9** *on Reply Card*

Gas Detectors

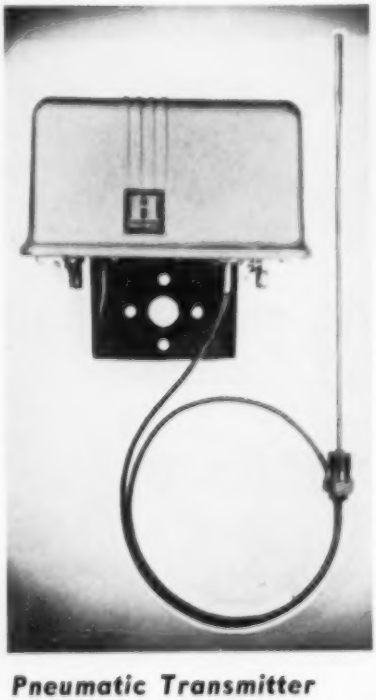
. . . **measure flammable gases** and vapors, and can be easily transported.

Weighing only six lbs., each of the four different models is powered by eight dry-cell flashlight batteries. Samples of the atmosphere to be analyzed are drawn into the instrument by squeezing an aspirator bulb. A balanced Wheatstone Bridge circuit, with current supplied by the flashlight batteries, tests in a few seconds for combustibility. Batteries must be replaced after 10 to 11 hours of continuous service.

The amount of flammable gas or vapor in the sample is shown on a calibrated meter, reading in percentages of lower explosive limit concentration. It will also indicate when concentrations are within or above the upper explosive limit. Flame arrestors on both sides of the sample flow system permit use of the instrument in testing for hydrogen and acetylene in air, as well as for other flammable vapors.

The instrument is housed in a cast aluminum case, 5 x 4 x 6 in. The indicating meter mounted flush in the top panel uses a core magnet movement, which prevents interference from magnetic fields that might be encountered in use. The four available models are designed to suit all industrial needs, with Model 30 able to differentiate between natural gas and petroleum vapors. **Mine Safety Appliances Co.,** 201 N. Braddock Ave., Pittsburgh 8, Pa.

Circle No. **10** *on Reply Card*



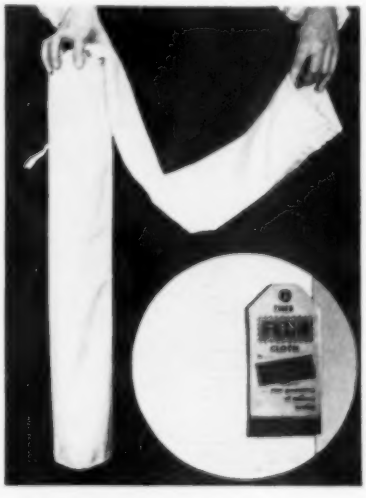
Pneumatic Transmitter

. . . **measures temperature or** pressure, and converts the readings to a standard 3-15 psi output.

This Tel-O-Set transmitter converts process temperatures from −375 to 1000°F, or pressures from 40 to 600 psi to a standard pneumatic output. Adjustments permit varying the span width or shifting it anywhere within the range of the instrument. Shock mounted and designed to resist the effects of vibration, the unit compensates for ambient temperature and barometric pressure changes.

The instrument operates on the force-balance principle, which virtually eliminates motion. A small, highly sensitive stainless steel bulb provides fast response for temperature changes. Low-pressure tubing, not long-run capillary, is used for economical installation. **Minneapolis-Honeywell Regulator Co.,** 4493 Wayne and Windrim Aves., Philadelphia 44, Penn.

Circle No. **11** *on Reply Card*



Orlon Filter Felt

. . . **combines high temperature** and chemical resistance with very high bursting strengths.

The fine filtering characteristics of felt are obtained by packing the interstices of a special Orlon woven fabric with short fibers of the same material. The principal applications are for filter presses and dust collectors with operating temperatures up to 300°F.

The Orlon fabric resists strong mineral acids and oxidizing chemicals and is unharmed by common solvents, oils, greases and acid salts. It has fair resistance to weak alkalies. No bonding resins are used and the edges and holes are cut by an exclusive heat-sealing process which prevents unraveling. It is available as yard goods or tailored to fit any type of filtration or dust collection equipment. Filtration Fabrics Div., **Filtration Engineers Inc.,** 155 Oraton St., Newark 4, N.J.

Circle No. **12** *on Reply Card*

(Continued on page 182)

CONDENSER TUBE CLINIC

Edited by Arthur W. Tracy,
Metallurgical Engineer,
The American Brass Company,
Waterbury, Connecticut

25 Years' Experience has proved the Value of Arsenic as an Inhibitor

Research at The American Brass Company nearly a quarter of a century ago showed that about 0.04% arsenic would inhibit dezincification of brass, and this amount of the element has been added to Admiralty metal and aluminum brass since then.

Inland power stations find that ANACONDA Arsenical Admiralty-439 serves well under normal water conditions, its arsenic content effectively inhibiting dezincification.

Tidewater power stations must contend with much more corrosive waters, and ANACONDA Ambraloy-927, the arsenical aluminum brass, is preferred because it is not only resistant to dezincification but also to impingement or erosion pitting by either clean or polluted sea waters flowing at relatively high velocities.

Oil refineries have virtually made ANACONDA Arsenical Admiralty-439 standard for refinery condensers and heat exchangers handling crudes, rerun stocks, cracked products, lubricating oils, and by-products. It is resistant to dezincification and can handle corrosive cooling waters at relatively high temperatures. Another important property is its ability to withstand attack by sulfur compounds resulting from the refining of sour crudes. ANACONDA Ambraloy-927, because of its resistance to dezincification and to pitting corrosion by sea water at relatively high velocities, is sometimes preferred in oil refineries on tidewater.

Marine users generally find ANACONDA Arsenical Admiralty-439 satisfactory for inland-water vessels and also for seagoing vessels where service conditions are moderate; but ANACONDA Ambraloy-927 is preferred for most seagoing vessels. Both alloys are resistant to dezincification under all corrosive conditions found in these services.

Your own needs may call for these corrosion-resistant Anaconda alloys or they may call for other tube alloys we make. Our Technical Department will be glad to help you select the one best alloy for the conditions you face.

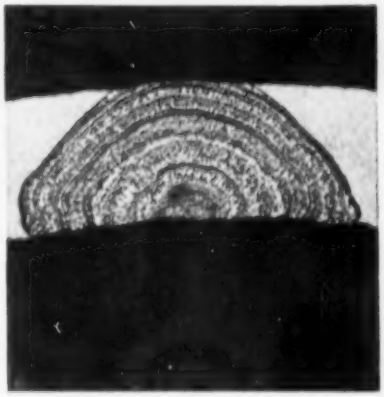
Technical Service—Get full information on our technical services and products by writing The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

APPROXIMATE MECHANICAL AND PHYSICAL PROPERTIES
(Light Annealed Tubes)

	Arsenical Admiralty-439	Ambraloy-927
Tensile Strength, psi.	52,000	60,000
Yield Strength, 0.5% Elongation, psi.	22,000	27,000
Elongation in 2", %	60	55
Rockwell Hardness "B"	6-45	35-65
Density, Lb./cu. in.	0.308	0.301
Thermal Conductivity, B.T.U. Sq. Ft. In. Hr. / °F. at 68°F.	768	696
Coefficient of Linear Expansion, Average per °F. (77°-572°F.)	0.0000112	0.0000108

TWO TYPES OF DEZINCIFICATION IN NONARSENICAL CONDENSER TUBES

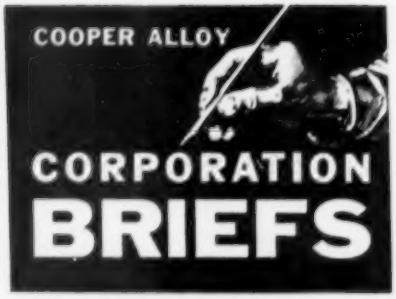
(approx. 120X)
LAYER-TYPE DEZINCIFICATION on the inner wall of an uninhibited Admiralty metal tube from an oil refinery using polluted fresh water.



(approx. 17X)
PLUG-TYPE DEZINCIFICATION on the inner wall of an uninhibited Admiralty metal condenser tube from a power plant operating on tidewater.

ANACONDA®
Tubes and Plates for Condensers and Heat Exchangers

(To obtain more data on advertised products see page 174)



• Edited by GEORGE BLACK

VALVE CLINICS

In spite of our belief that the Cooper Alloy stainless steel valve offers the best in design and operating features, we take it to school regularly. This "school" consists of continual study by field engineers, design engineers and by industry itself subjecting it to intensive examination and reporting their findings at organized Valve Clinics.

Cooper Alloy Valve Clinics have been held in dozens of leading plants, including Dow, DuPont, Mathieson, Celanese, Pfizer and many others. Arrangements for such a clinic in your own plant may be made through our Public Relations Division.

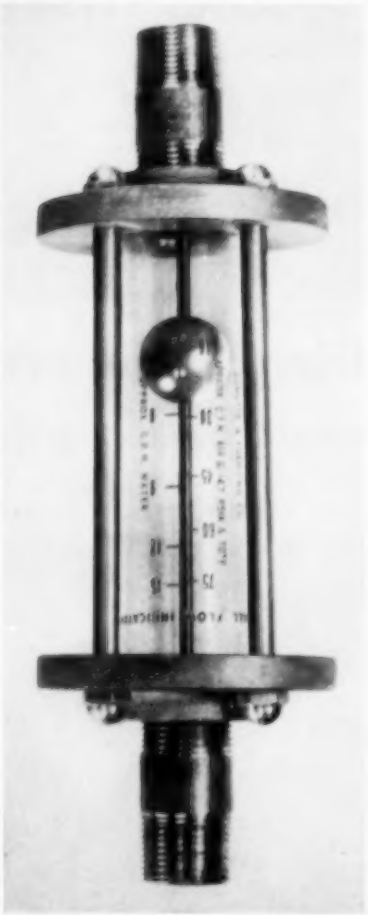
"FLEX-ALLOY" STAINLESS PUMP

A new line of stainless steel rotory pumps for corrosive solutions, abrasive slurries and fluids which must be kept free from contamination has just been announced by our Vanton Pump & Equipment Division. Called "Flex-Alloy" these new pumps in type 304 or 316 stainless (other alloys on request) incorporate the same no-stuffing box, no-shaft seals, no-gasket features of the popular "flex-i-liner" plastic pump series. Full details are given in Bulletin VP561.

FAST AND COLD

On October 14, 1947, the Bell X-1 made history by flashing through the skies faster than sound. Cooper Alloy is proud to have been teamed with the Glasby Company in helping Bell Aircraft carve its notch in history by furnishing the 30" diameter, 3" wall stainless steel sphere required for handling the liquid nitrogen.

COOPER ALLOY
CORPORATION • HILLSIDE, N.J.



Flow Indicator

. . . **provides a dual scale** for approximate measurement of water flow (in gpm) and air flow (in cfm).

Using a ball on a guide rod, installed in a tapered glass tube, the indicator gives an approximation for the rate of flow of either fluid. Recommended for use when the flow is in one direction only, the bronze indicator must be mounted in a vertical pipeline. The graduations are visible from almost any direction. It is available in ¼, ½, ¾, 1, 1½ and 2-in. pipe connection sizes. **Schutte and Koerting Co.,** Cornwell Heights, Bucks County, Pa.

Circle No. **13** *on Reply Card*

Hard Water Scale

. . . **is prevented or removed** by a treatment developed as a result of work in the fields of chelate and surface chemistry.

Designed to control sulfate, ferric oxide or carbonate scale in valves, pipes, tanks, cooling towers, evaporators, heat exchangers and other equipment using large quantities of water, "KE-TONE" is simple to use. Added to the water at the rate of 1 lb. to 200,000 grains of contained water hardness, or from 3 to 5 ppm—whichever gives the highest concentration of treating agent—it will prevent new scale forming as well as dissolve existing scale. In fact, a daily check on the system will show a gradual rise in hardness caused by existing scale in the system disintegrating or going back into solution. Frequent blow-downs will keep the hardness to reasonable levels. When the system is free of scale the hardness will return to its initial value.

By a degradation process "KE-TONE" suspends scale particles in some areas and allows the scale to dissolve in others. It does not favor precipitation of calcium or magnesium from the water. It is also claimed to reduce or eliminate algae growth, especially desirable in cooling towers. **United Chemical Corporation of New Mexico,** Hobbs, N.M.

Circle No. **14** *on Reply Card*

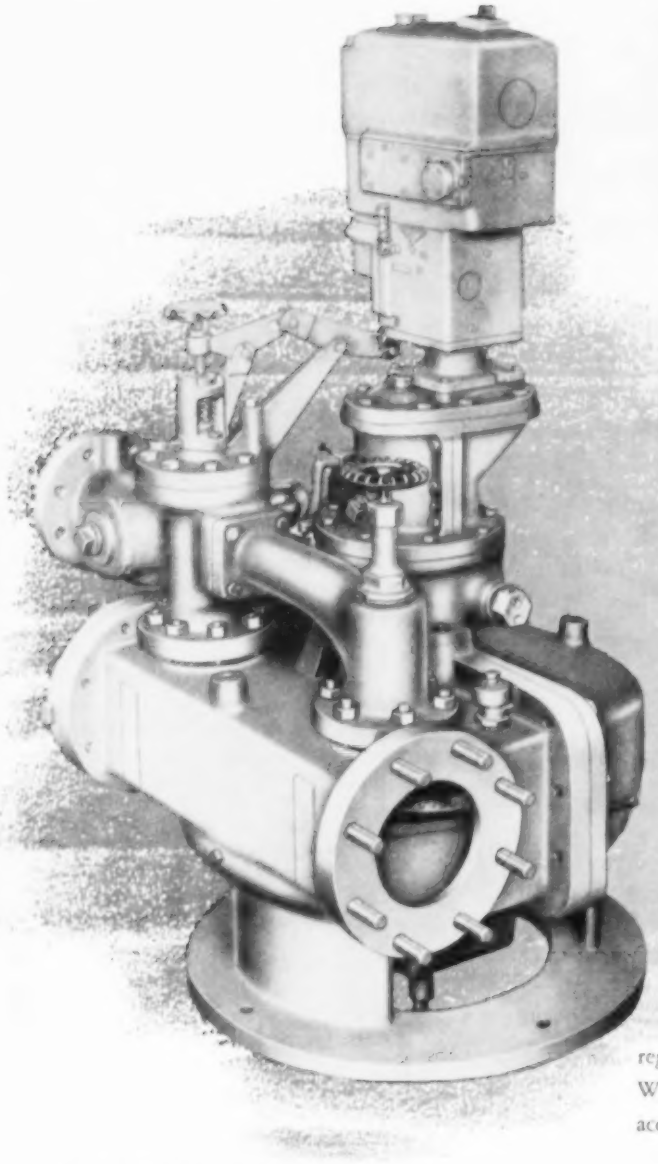
Pipeline Repair Clamp

. . . **permits permanent repair** of cracked or broken pipe. It also can be used to connect lengths of cast-iron, steel or asbestos-cement pipe in a trench.

The clamp bands are made of cold rolled copper or stainless steel, and are supplied with silicon bronze or stainless steel bolts for corrosive conditions. The matching halves are preassembled with a gridded gasket and armored insert for direct application to the pipe surface. Sizes are available for nominal pipe sizes of 2 through 24 in. **Smith-Blair Inc.,** 535 Railroad Ave., South San Francisco, Calif.

Circle No. **15** *on Reply Card*

(Continued on page 184)



where speed control counts

DH *turbines deliver accurate speed control where you need it.*

Ideal for all drives requiring extremely close speed regulation, Dean Hill Steam Turbines equipped with Woodward Type PG Governors guarantee maximum accuracy.

This governor is adaptable to either the vertical or horizontal Dean Hill Turbine, and unlike most types of governors, it is "isochronous", holding a steady speed within a band of 0.1% to 0.03% over an extremely wide range of turbine speed, regardless of the load on the pump. All DH Turbines come equipped with over-speed trip valve.

For further information on D-H Turbines and optional accessories

write today for Catalog 500.

DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1893

Indianapolis 7, Indiana

Sales Offices In:

Chicago, New York, Seattle, Birmingham, Ala., Knoxville, Louisville, Memphis, Boston, Springfield, Ill., St. Louis, Kansas City, Cincinnati, Albuquerque, Casper, Wyo., Salt Lake City, El Paso, New Orleans, Denver, Washington, Toledo, Minneapolis, Grand Rapids, Los Angeles, San Francisco, Pittsburgh, Dallas, Houston, Cleveland, Philadelphia, Tulsa, Marshall, Texas, Mimico, Ont., Montreal, Vancouver, Reading, Pa., Santurce, Puerto Rico.

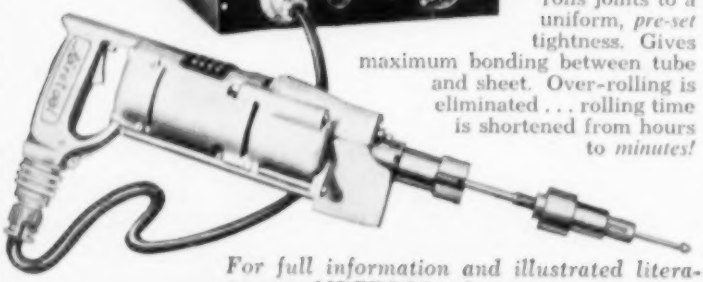
KNOCK-DOWN
costly downtime at "turn-around" time, with AIRETOOL

Here's AIRETOOL'S "One-Two" punch that will lower costly downtime and high maintenance expenditure with a minimum of lost stream time.

AIRETOOL'S lightweight internal tube cutter. Hand held, quickly removes damaged or leaky tubes. Cuts steel or non-ferrous tubes up to 2½" dia. Hardened tool steel DOUBLE tool bits center themselves . . . ball bearing thrust collar and easy feeding action for fast cutting. Cuts internally through tube sheets up to 4" thick . . . 12 to 20 gauge.

MOBILE UNIT

AIRETOOL'S automatic tube expansion control system quickly rolls joints to a uniform, *pre-set* tightness. Gives maximum bonding between tube and sheet. Over-rolling is eliminated . . . rolling time is shortened from hours to *minutes!*



For full information and illustrated literature on AIRETOOL tube maintenance equipment best suited to your needs, write AIRETOOL Mfg. Co., Springfield.

AIRETOOL
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

BRANCH OFFICES:
New York, Chicago, Tulsa, Philadelphia, Houston, Baton Rouge

REPRESENTATIVES in principal cities of U.S.A., Canada, South America, Mexico, England, Europe, Japan, Italy, Hawaii, Puerto Rico
EUROPEAN PLANT: Vlaardingen, The Netherlands

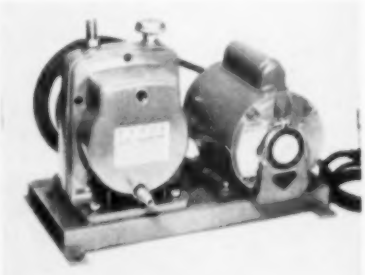
Portable Sand Blaster

. . . **permits clean operation** inside tanks, on overhead surfaces and in other hard-to-reach areas.

Weighing only 10 lbs., including an abrasive charge, the "Educt-O-Matic" is really a portable blast cleaning nozzle surrounded by a vacuum cleaner. The abrasive and resulting dust are carried into the body of the machine. The abrasive returns to the feed hopper and the bag retains the dust. The absence of any flying abrasives provides safety to adjacent workers and equipment. A "deadman's" control stops the unit should the operator's grip slip.

A variety of abrasives can be used, including: malleable shot and grit, aluminum oxide, walnut shells or steel grit. Operated by compressed air, it consumes 33 to 60 cfm; recommended pressure is 90 to 100 psi. **Clementina Ltd.,** 2277 Jerrold Ave., San Francisco 24, Calif.

Circle No. **16** *on Reply Card*



High Vacuum Pump

. . . **guarantees 0.1 micron** ultimate vacuum, and delivers a free air displacement of 20 liters/min.

Vibrationless and noiseless, the Hyvac 2 can pump from atmospheric to ultimate pressure in about 5 minutes. More compact than previous

TC CUPRIC CHLORIDE

MADE FROM VIRGIN COPPER FROM OUR OWN MINES

PRODUCED BY THE

TENNESSEE CORPORATION

MINERS OF COPPER, ZINC, IRON AND SULFUR.

A SUPERIOR SWEETENING REAGENT IN PETROLEUM REFINING

We are in a position to supply your needs on annual, semi-annual or monthly contract basis—also smaller quantities in drop shipment lots.

CUPRIC CHLORIDE DI-HYDRATE

TYPICAL ANALYSIS

Copper	37.00% minimum
Moisture	12.00% maximum
Fe	.04% maximum
Zn	.01% maximum
Copper Exychloride—less than	.50% maximum

CHECK THESE FEATURES

High Copper Content
Lower Moisture
Uniform Particle Size
Uniformity
Availability
For
1. Quality Improvement
2. Cost Reduction

Other Tennessee Corporation products:
Ferric Sulfate (Ferri-Floc),
Copper Sulfate
and
Sulfur Dioxide.

For samples make request on your company letterhead.

TENNESSEE TC CORPORATION

617-629 Grant Building, Atlanta, Ga.

LINCOLN

Available electric or gasoline driven, explosion-proof, vapor-proof, water-proof.

Self-Propelled
AUTO SCRUBBER
Automatically
Does **5 JOBS!**

1. SPREADS SOLUTION
2. SCRUBS
3. RINSES
4. PICKS UP
5. DRIES

For Buying Facts Write

Lincoln-Schlueter Floor Machinery Co. is a subsidiary of American.

THE AMERICAN FLOOR SURFACING MACHINE CO. ESTABLISHED 1905

5681 So. St. Clair St. Toledo 3, Ohio

Lincoln *is* automatic floor maintenance *at its best*—engineered to last! Big business knows this—that's why you'll find organizations such as Ford Motor Co., Proctor & Gamble, Philadelphia International Airport, Northwestern University and many others using Lincoln Auto Scrubbers. One machine does work of up to 12 men! Five models for all size floors. Engineered by practical men so you can have *extra clean* floors with minimum effort and maximum savings. Write today for a free demonstration by our experts. No obligation.

PERFORMANCE PROVED MAINTENANCE MACHINES • WORLD-WIDE SALES AND SERVICE

OIL MEN Specify:

2200-5000 Volts

Diesel-Loading pumps with EC&M Div. 2 Starters.

EC&M

50,000 KVA
Interrupting Capacity
MOTOR STARTERS

OUTSTANDING ADVANTAGES

1. Reduced floor space
2. Low-cost Div. 2 design
3. 50,000 KVA interrupting capacity
4. Combination starter with Disconnect Switches
5. Corrosion resistant, weather-proof construction
6. Copper tungsten contacts for positive operation
7. Simple 3-wire TIME-DELAY UVP push button circuit
8. THERMAL-MAGNETIC Overload Relays give accurate motor protection . . . trip instantly on faults
9. All internal wiring complete
10. Self-contained bus and pot-heads are optional

Petroleum engineers specify these Starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: Type III weather-resisting enclosure with drip-proof roof, tank-cover and front-cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . overload and control relays in flanged (Class I, Group D) enclosure with removable cover . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit. "Stop circuit" opens without delay when "Off button" is pressed.

EC&M 2200-5000 volt Starters are also available in Totally Oil-Immersed Division 2 Style and in Division I style. Both are available with Oil Disconnect Switch (for main line).

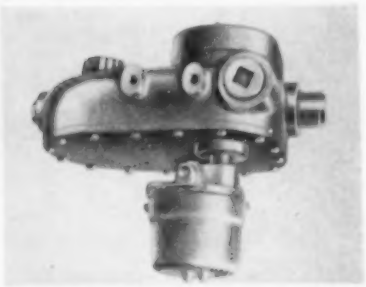
Write for 16-page Booklet 1062 for complete details.

THE ELECTRIC CONTROLLER & MFG. COMPANY
A DIVISION OF SQUARE D COMPANY
4498 LEE ROAD • CLEVELAND 28, OHIO

models, the new pump measures 10 x 15 in. overall, with a height of 11 in. The mounting base is 7 x 15 ins.

Six motor arrangements are available to meet most voltage requirements: 115 and 230 volt for 60 cycle, 115 and 230 volt for 50 cycles, and an explosion-proof (Type 10) and a 3-phase (Type 18). **Central Scientific Co.,** 1700 Park Road, Chicago, Ill.

Circle No. **17** *on Reply Card*



Level Control

. . . is operated by either air or gas pressure for actuating pumps, motor-operated valves or other operating equipment.

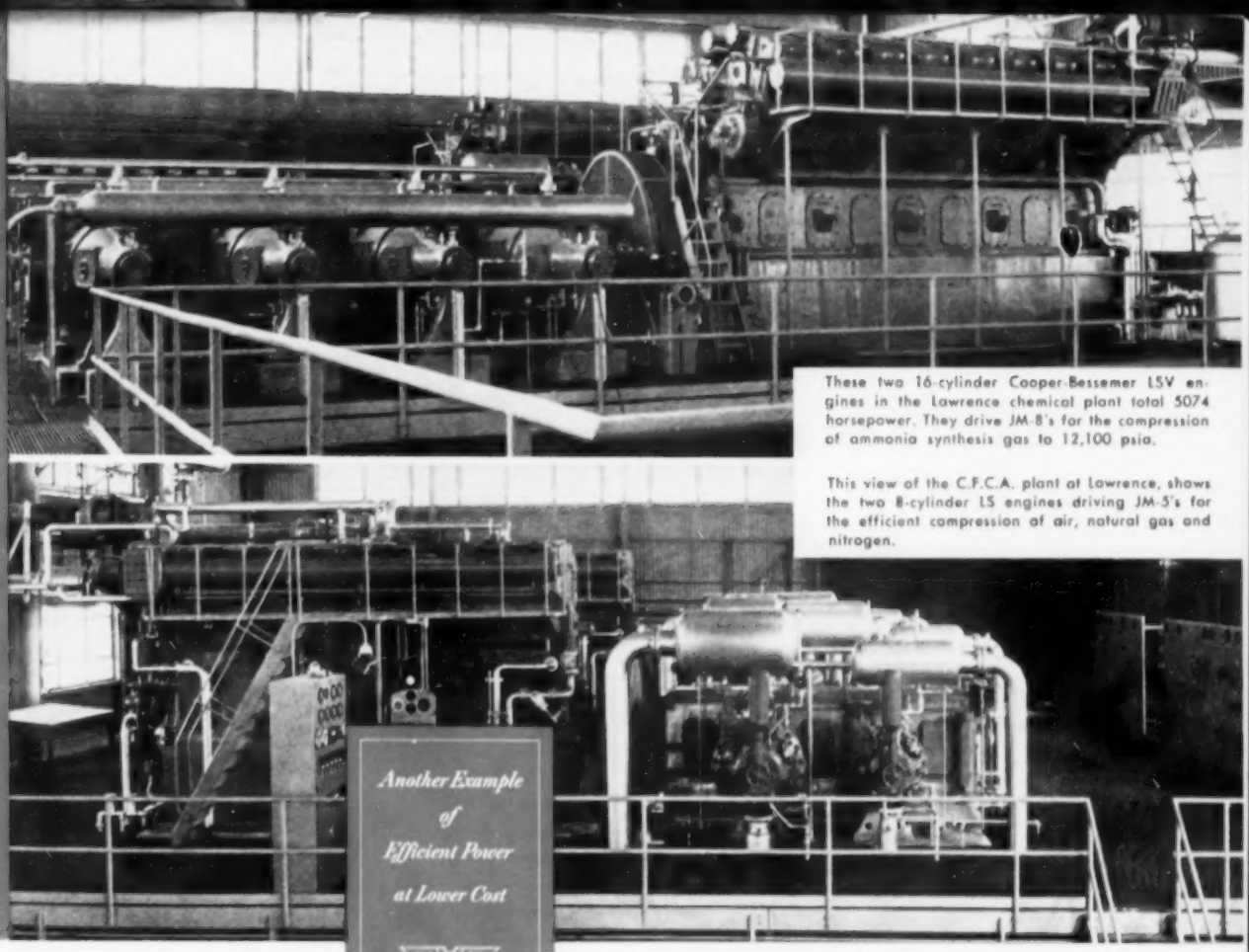
Designed to trip at either high level, or at both high and low levels, the units are mounted on the automatic tank gauge or other type of tape reading and high pressure gauges. The unit is triggered by a cam, which can be adjusted to operate at any float position within a range of 24 feet. **Vapor Recovery Systems Co.,** 2820 N. Alameda St., Compton, Calif.

Circle No. **18** *on Reply Card*

Pipe Leaks

. . . are repaired quickly with steel patch, which can be welded to the pipe by conventional or "Cold-Weld" process.

The tool consists of a pipe clamp and the shaped-and-gasketed steel patch. The clamp is placed around a



These two 16-cylinder Cooper-Bessemer LSV engines in the Lawrence chemical plant total 5074 horsepower. They drive JM-8's for the compression of ammonia synthesis gas to 12,100 psia.

This view of the C.F.C.A. plant at Lawrence, shows the two 8-cylinder LS engines driving JM-5's for the efficient compression of air, natural gas and nitrogen.

Another Example of Efficient Power at Lower Cost

Cooper-Bessemers at C. F. C. A.'s Lawrence Plant UNIQUE! IN SIZE IN PERFORMANCE IN ECONOMY

• In Cooperative Farm Chemical Association's $16,000,000 Lawrence, Kansas plant, the largest engines and largest compressors manufactured by Cooper-Bessemer are combined to offer unitized machines boasting important advantages.

Two giant 4-cycle turbocharged LSV-16 engines, rated 2537 hp at 240 rpm, are directly connected with JM-8's for compressing ammonia synthesis gas from 275 psia to 12,000 psia. Obviously this big-unit setup meets requirements with far fewer engines than would be needed otherwise, resulting in less piping, less foundation and less supervision. What's more, there's previously unheard of fuel economy.

Similarly, the plant contains two LS-8 engines, rated 1852 hp at 330 rpm, combined with JM-5's for the compression of three separate gases on three individual services . . . air from 120 psia to 630 psia, natural gas from 115 psia to 430 psia and nitrogen from 35 psia to 330 psia.

Although scheduled for continuous full-load duty, these Cooper-Bessemer units can be easily operated at variable loads as required. In addition, they offer *extra* economy because they can operate efficiently, dependably on natural gas, diesel fuel or any combination of these fuels.

For information on new operating economies possible in *your* service, contact any of the Cooper-Bessemer offices listed below.

MOUNT VERNON, OHIO
COOPER-BESSEMER
GROVE CITY, PENNA.

New York City • Seattle, Wash. • Chicago, Ill. • Houston, Dallas, Greggton, Pampa and Odessa, Texas • Washington, D. C. Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. Caracas, Venezuela • COOPER-BESSEMER OF CANADA, LTD., Edmonton and Calgary, Alberta, Canada.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

"Alamask"

offers a complete and diversified line of reodorants for petroleum and allied products

No longer need the products of the petroleum industry inflict upon their users the obnoxious odors resulting from the mercaptans and sulfides in their processing.

Years of development work and product-testing have culminated in a complete line of Alamask® reodorants that can successfully mask the objectionable odors of many petroleum products. Check this table to see which Alamask reodorants will solve *your* malodor problems:

"ALAMASK"	GASOLINE FRACTIONS	ASPHALTIC COMPOUNDS	KEROSENE BLENDS	COAL SPRAY OILS	SPACE HEATERS	CUTTING OILS	CLUTCH OILS	DIESEL FUELS	JET FUELS	MINERAL SPIRITS	WAXES	NAPHTHA	BURNER OILS
AAM								X					
AO						X	X						
AR		X								X			
BGM		X											
BN						X	X						X
BUL				X	X			X			X		X
CC			X							X			
CE			X							X			
CX											X		
MS			X							X	X	X	X
0.19	X				X	X	X		X				X
0.20	X				X	X	X		X				X
TO									X				

Rhodia's chemists and engineers, experienced in odor abatement and waste disposal, will provide technical assistance to you in your efforts to correct malodors.

For complete information on these new, highly-effective reodorants, write today to Rhodia, Inc., Industrial Reodorants ("Alamask") Division, 60 East 56th Street, New York 22, N. Y.

Rhodia INC.

You'll Want a REPRINT for your own files of
"It's Time to Take a New Look at
CATALYTIC REFORMING"
the special 48-page report from the August 1955 issue of
Petroleum Processing
Single copies—$0.75, postpaid

Send orders to:
Reader's Service Dept.
Petroleum Processing
330 West 42nd Street
New York 36, N. Y.

OR

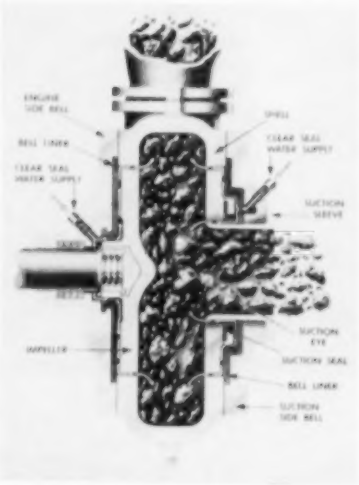
There's a new, easy way to order single copies of this reprint. Circle number "R3" in Area "C" of the Reader's Service Card in this issue —pages 175-176.

(New York City residents, add 3% city sales tax)

leaking pipe without shutting of the line or reducing the pressure. The patch is applied directly over the leak and pressure is applied by a wrench. When the leak is sealed the clamp can be left on or the patch can be welded.

Welded patches have been tested as high as 6000 psi. In locations where welding is prohibited a Cold-Weld cement is applied to both the pipe and the patch, before the patch is left in place. After 1 to 2 days the clamp can be removed. Patches applied by this Cold-Weld method have been tested to 2000 psi. **Atlas Industries, Inc.,** P. O. Box 8152, Houston, Texas.

Circle No. **19** *on Reply Card*



Abrasive Material Pump

. . . handles petroleum coke, using a clear water seal to protect the rotating parts of the pump.

Designed to handle ash, slag and fly ash, as well as coke, the pump permits a small stream of water to flow continuously through the clearance spaces between the rotating impeller and the stationary parts of the shell. This water seal protects the shaft, stuffing box and suction seal from the abrasive particles; it also prevents recirculation of the solid-fluid mixture back to the suction eye of the impeller.

Two types are available. One uses a rubber, neoprene or other synthetic lining and is suitable for pumping fine solid materials, especially where resistance to chemical action is critical. A second type uses hard metal alloy wearing parts. It will handle the sharp edged solids which can often cut the softer, non-metallic linings. **Allen-Sherman-Hoff Co.,** 259 E. Lancaster Ave., Wynnewood, Pa.

Circle No. **20** *on Reply Card*

(Continued on page 190)

Clad steel will give us the same protection and long equipment life as solid high alloy!

...and at a down-to-earth cost!

Clad steel demonstration unit recently featured at the Nat'l Assoc. of Corrosion Engineers show.

LOOK AT THE RECORD!

SEE FOR YOURSELF!

ECONOMY—high-alloy layer assures corrosion resistance, long equipment life.
STRUCTURAL STABILITY—low-cost backing steel provides strength and rigidity.
DESIGN FREEDOM—integral bond allows design and fabrication of shapes to meet process and space needs.

■ Use of clad steel is growing fast throughout the petroleum and petrochemical industries. You see it wherever corrosion or product contamination are problems—in fractionating towers, desulphurizers and other vital equipment.

Even if you *could* afford solid high alloy, you couldn't buy better, more lasting protection than this. Economical clad steel offers the benefits of solid high alloy—*at a practical price*. The permanent, integral bond between cladding and backing steel simplifies construction—eliminates seepage and crevice corrosion. Extreme heat, cold, and quick temperature changes won't affect it!

Add to this, clad's easy maintenance. Add easy modification—walls can be cut, flanges or pipes welded on quickly and easily, without injuring clad surface or bond!

And only Lukens offers a selection of 16 cladding and 11 backing metals—practically an unlimited selection of cladding and backing combinations to meet any conceivable need.

For more information consult your equipment builders or write to Manager, Marketing Service, Lukens Steel Company, 841 Lukens Building, Coatesville, Pennsylvania.

We'll show you in detail just why we say *clad steel is the ideal material for long range economy.*

LUKENS CLAD STEELS

LUKENS

STAINLESS-CLAD • NICKEL-CLAD • INCONEL-CLAD • MONEL-CLAD

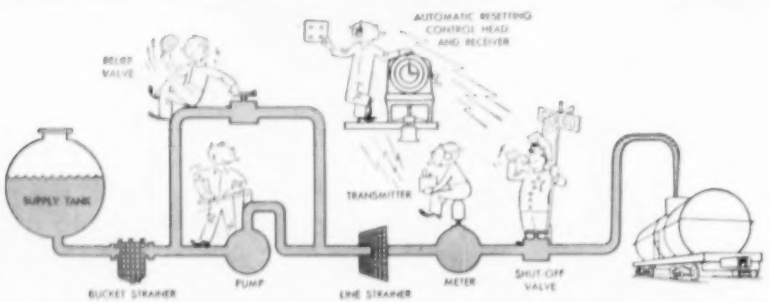
Producers of the Widest Range of Types and Sizes of Clad Steel Plates and Heads Available Anywhere

LITHIUM METAL AND ALLOYS
LITHIUM HYDRIDE
LITHIUM HYDROXIDE
LITHIUM CARBONATE
LITHIUM CHLORIDE—BRINE—ETC.

LITHIUM
MAYWOOD

Pioneers in Lithium since 1901

MAYWOOD CHEMICAL WORKS
MAYWOOD, NEW JERSEY
ESTABLISHED 1895



TYPICAL REMOTE CONTROL FLUIDOMETER SYSTEM

For Use Where Valves Must Be Located In Hard-to-get-to Places

This animated picture illustrates a typical remote control Fluidometer application. Remote control of this general type is recommended when plant conditions or arrangement make direct control impractical or impossible. With a system of this type the Fluidometer control head can be located away from the meter. Shown at the left is the automatic resetting control head, which controls the operation of the shut-off valve to give completely automatic batching. Available either jacketed or unjacketed—"tailor made" to fit your needs. New Bulletin Fl-56 will be sent on request. For information on jacketed pipe and fittings write for Bulletin J-56.

HETHERINGTON & BERNER INC. • *ENGINEERS-MANUFACTURERS*
715 KENTUCKY AVENUE **INDIANAPOLIS 7, INDIANA**

Grease Pump

. . . for emptying 400-lb. drums is pneumatically operated. It empties the drum and wipes the sides clean.

The pump unit is suspended on a two-way "A" frame mounted on wheels. The frame is rolled over the drum, which remains on the floor, and the pump is lowered until in contact with the drummed product. As the control valve is opened, the product travels from the drum through a 2-in., 10 ft. long, neoprene hose. The unit will remove LNGI No. 2 lithium based grease at the rate of 150 lb./min.

Although the standard model is completely operated by air it is possible to order a special model furnished with an electric-hydraulic arrangement. **Barrett Manufacturing Co.,** P. O. Box 8096, Houston, Texas.

Circle No. **21** *on Reply Card*

Free Trade Literature

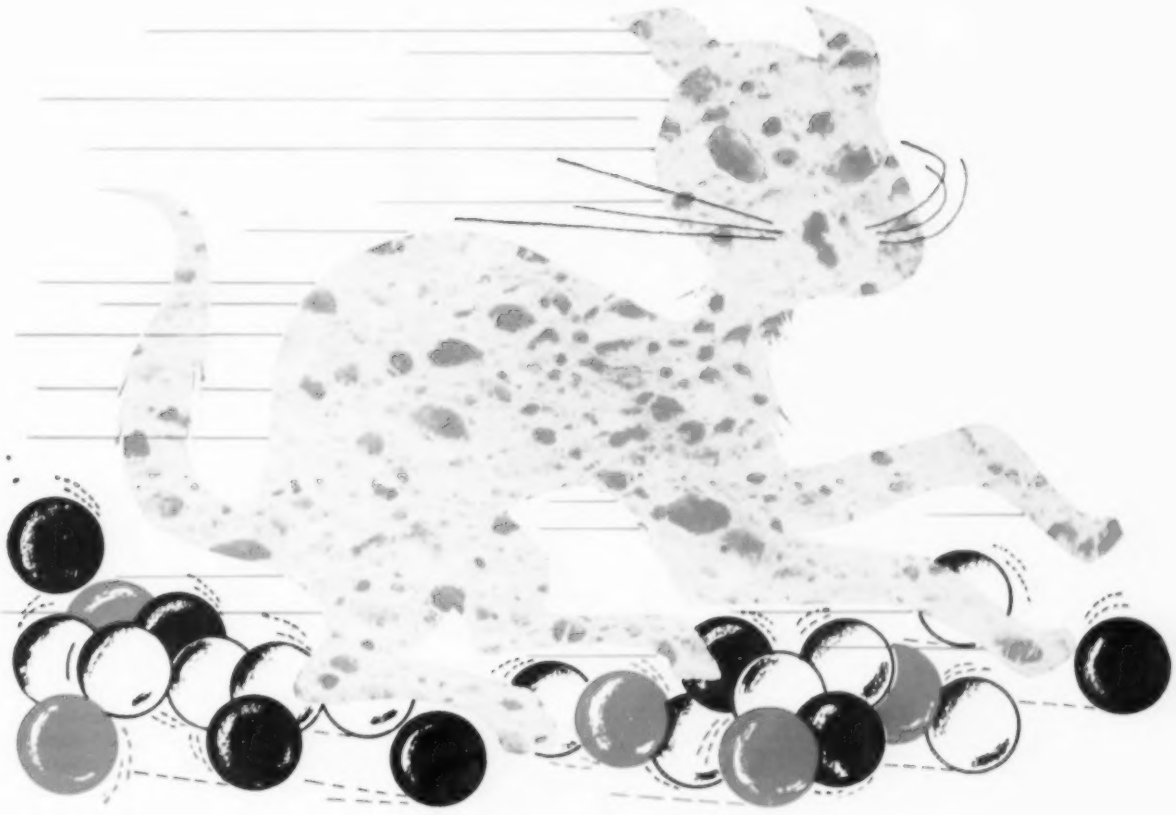
PVC Fittings and Flanges

. . . in normal and high impact grade polyvinyl chloride: catalog, *PVC Pipe Fittings and Flanges,* describes characteristics and advantages of this material for piping. Listed are the operating temperatures, pressures, price comparisons, fabrication advice, dimensions and weights. All installation and supporting recommendations are based upon latest field experience. Grinnell Co., Inc., 260 W. Exchange St., Providence 1, R.I.

Circle No. **22** *on Reply Card*

Condensate and Vacuum Pumps

. . . their construction, capacities and selection: *Bulletin No. 1465* is a 28-page catalog of various types of condensate pumps vacuum pumps, listing



SPHERICITY SPEEDS FLOW, REDUCES ATTRITION OF

balanced HI PV* Aerocat® Catalysts

Circulation improves and stack losses drop when catalyst particles are free of snags and corners that impede flow and break off to make fines.

Good sphericity is characteristic of Cyanamid's AEROCAT Catalysts. Balanced with particle size distribution and hardness, sphericity boosts efficiency of catalytic cracking. And to provide exceptional thermal and steam stability, high pore volume is carefully adjusted with pore diameter and specific surface.

Results in cat cracking unit performance are attested by extensive commercial experience, which your Cyanamid representative will be glad to review with you. Ask him today about AEROCAT, and the importance of a *balanced* HI PV catalyst.

*Trademark
®Registered Trademark

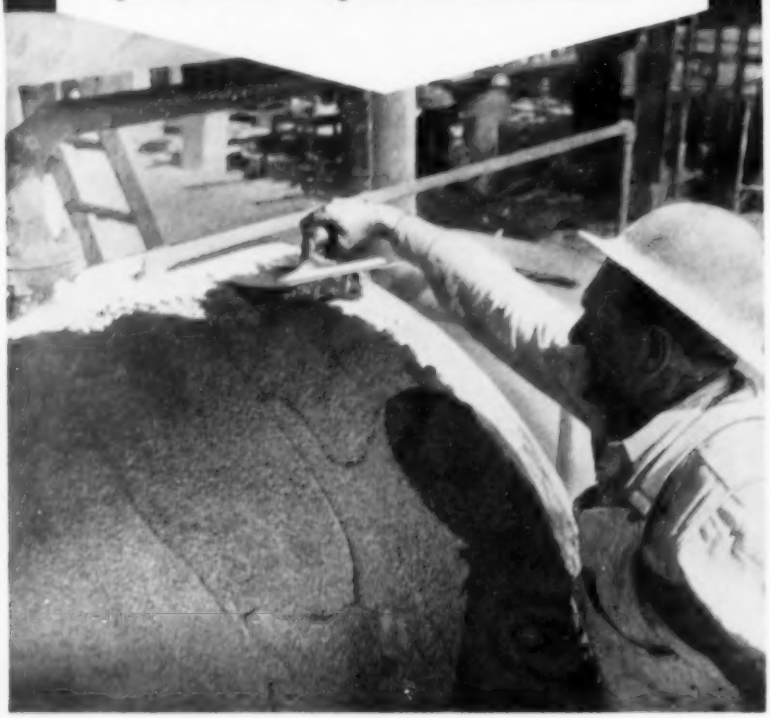
CYANAMID

AMERICAN CYANAMID COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza, New York 20, N.Y.

In Canada: North American Cyanamid Limited, Toronto and Montreal

Laykold® WEATHERCOAT

protects exposed insulation



INSULATION on towers, tanks and exchangers must be kept DRY. If moisture gets through, the efficiency drops.

Modern refinery and plant design places many major insulated vessels "in the open." You can maintain the efficiency of your insulation with easy-to-apply Laykold Weathercoat.

Weathercoat is a fibrated asphalt-base material of easy troweling consistency that dries to a black, remarkably tough and tenacious coating. A majority of the leading refineries are regular users of Weathercoat.

A new product: Mastic Weathercoat, a bodied material, for use wherever economy demands the application of a *single*, thick layer.

Write today for our free illustrated brochure, entitled "Laykold Weathercoat for Insulation Protection."

ABA

American Bitumuls & Asphalt Company

200 Bush Street, San Francisco 20, California — Perth Amboy, N. J.
Baltimore 3, Md. — St. Louis 17, Mo. — Cincinnati 38, Ohio
Mobile, Ala. — San Juan 23, P.R. — Tucson, Ariz.
Inglewood, Calif. — Oakland 1, Calif. — Portland 7, Ore.

LEADING MARKETERS OF ASPHALTS, CUTBACKS AND BITUMULS – NATIONWIDE

engineering data and dimensions for specification, as well as installation diagrams and a pump selection guide. Sarco Co., Inc., Empire State Bldg., New York 1, N.Y.

Circle No. **23** *on Reply Card*

Metering Pump Accuracy

. . . and the factors involved: *Technical Paper No. 65* describes how controlled volume pumps, because of their high volumetric efficiency and accuracy, are used as flow control instruments in both open and closed loop instrumentation systems. Illustrated are typical systems in which controlled volume pumps are used as flow controllers, ratio controllers and final control elements. Milton Roy Co., 1300 E. Mermaid Lane, Philadelphia 18, Pa.

Circle No. **24** *on Reply Card*

Thermal Cements

. . . improve heat transfer between tracings and process equipment. Booklet, *Thermal Conducting Cements*, describes this special material developed as a substitute for expensive steam jacketing. Called "Tracit," the nonmetallic, inorganic plastic cement self hardens to produce a dense and high conductive product. It may be used on either heating or cooling systems. Chemax Mfg. Corp., 900 Wilmington Rd., New Castle, Del.

Circle No. **25** *on Reply Card*

Rust Prevention Catalog

. . . includes color chips of 102 finishes available from Rust-Oleum; *Form No. 255* presents reasons for selecting various types of rust prevention finishes, how to mix and apply them, and the results of recent tests on these fish-oil base products. Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

Circle No. **26** *on Reply Card*

Steam Generators

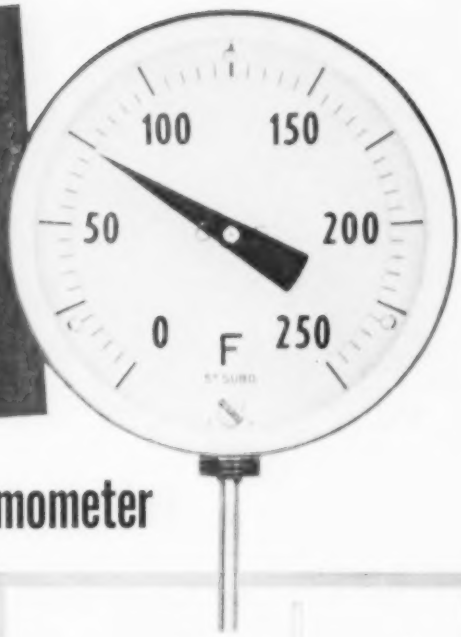
. . . and their construction: *Bulletin 5511* includes technical data, table of dimensions, and drawings showing tube arrangement and gas passes for package units. Shop assembled, these 2-drum units have rated capacities from 7,500 to 40,000 lb./hr. Titusville Iron Works Co., Titusville, Pa.

Circle No. **27** *on Reply Card*

Epoxidation-Hydroxylation

. . . bulletin describes reactions of unsaturated olefins. *Bulletin No. 69*, a 49-pager, includes for the first time a description of two new *in situ* epoxidation processes: the ion-exchange resin

"Every Angle" Design Maxivision* Accuracy Bi-Metal Actuation

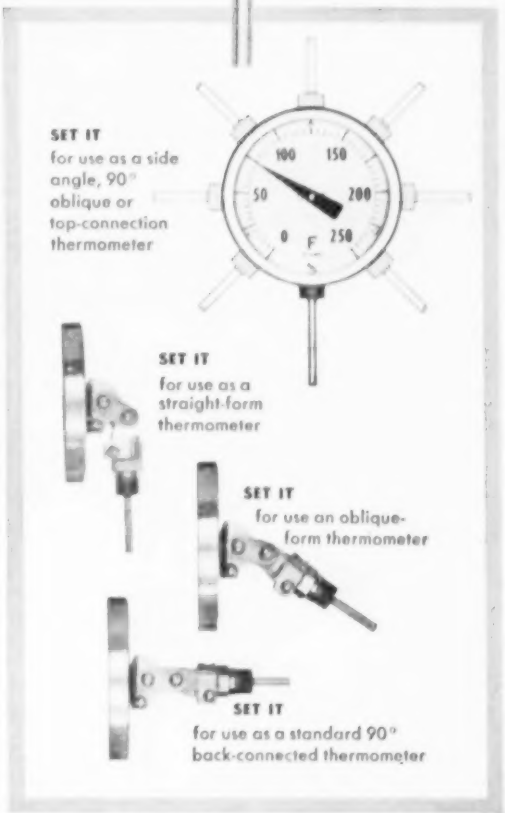


Now... all 3 in one 'American' Thermometer

Only this new American Thermometer* gives you the three features most demanded in a dial thermometer. The "Every Angle" design allows you to install this thermometer *anywhere* . . . then angle it in the direction that provides easiest reading. The anti-parallax Maxivision dial guarantees the surest, sharpest, easiest reading. Graduations are carried on a raised ring, set close to the cover glass, with an index-type, functional pointer set at the same level. The result — no perspective effect — parallax error practically eliminated. Finally, bi-metal actuation insures high sensitivity, economy, and surety of operation.

Install the new American "Every Angle" Bi-Metal Dial Thermometer anywhere — inside or out. Its climate-proof case defies any weather condition. The full use of these thermometers in any process plant makes possible temperature readings with the same ease and facility of those of a pressure gauge. Write today for complete information. Ask for Bulletin 148.

*Pat. App. For



SPECIFICATIONS

5-Inch Type 5-6060 American "Every Angle" Bi-Metal Dial Thermometer

Temperature Ranges: From minus 80° to plus 1000° F. Accuracy within 1% of range. *Dial Size:* 5". Scale approximately 10½" long. *Bi-Metal Coil:* Low mass, with single helix close to inside wall of stem assures high sensitivity. Silicone fluid dampens vibration, accelerates transfer, speeds response. *Case:* Stainless steel. *Bezel:* Threaded to case. *Front:* Clear, extra-heavy glass set in channeled gasket to seal case. *Pointer:* Functional type, adjustable from front. *Stem:* Lengths — 4" to 24", 18-8 stainless steel. All joints welded. *Connection:* Fixed, ½" NPT. *Separable Sockets:* Available in all materials and sizes normally required.

PHONE your Industrial Supply Distributor for experienced attention to your needs. He is always ready to help you ward off costly shut-downs through fast delivery from local stocks.

AMERICAN INDUSTRIAL INSTRUMENTS

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'AMERICAN' INDUSTRIAL INSTRUMENTS, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN MICROSEN' INDUSTRIAL ELECTRONIC INSTRUMENTS, *Stratford, Conn.* 'HANCOCK' VALVES, *Watertown, Mass.* 'CONSOLIDATED' SAFETY RELIEF VALVES, *Tulsa, Oklahoma.* AIRCRAFT CONTROL PRODUCTS, *Danbury & Stratford, Conn. and Inglewood, Calif.* 'SHAW-BOX' AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES, *Muskegon, Mich.*

BELMONT "hot oil" PACKING

For hot and cold oil rods and plungers. **Catalog No. 54.**

You can literally "boil it in oil" without affecting the efficiency of this Belmont No. 189 Hot Oil Packing.

Long fibre asbestos—each strand treated with a special compound to resist penetration and saturation—is braided, jacket over jacket. Guards against seepage and loss of product. Try it on your rods and plungers.

BELMONT "gasoline" PACKING

For piston rods and valve stems handling oil, gasoline, benzol, naphtha, kerosene. **Catalog No. 54.**

Eliminate the constant fire hazard of leaky stuffing boxes, in the handling of gasoline and other volatile distillates.

Use Belmont "6100" Packing—accepted by many of the leading oil refineries throughout the world for its superiority and safety.

Special lubricants retain the softness and essential sealing qualities of this braid-over-braid asbestos packing.

The Belmont Packing & Rubber Co.
Butler & Sepviva Sts., Phila. 37, Pa.

U.S. GASKET · BELMONT PACKING

catalysts-fixed bed and the expendable ion-exchange resin catalyst technique. One feature of the bulletin is a 9-page conversion table for rapid calculation of reactions involving iodine or bromine numbers. Becco Chemical Div., Food Machinery and Chemical Corp., Buffalo 7, N.Y.

Circle No. **28** *on Reply Card*

Vessel Fabrication

. . . techniques: *Catalog No. 554* tells in 48 pages the story of custom fabrication of tanks and pressure vessels. Useful for reference purposes is that part of the catalog that lists the corrosive action of 200 different chemicals (in various concentrations) on 16 different metals. These data have been developed with the aid of research laboratories of the largest metal producing companies. Nooter Corp., 1400 S. Second St., St. Louis, Mo.

Circle No. **29** *on Reply Card*

Compressed Air Problems

. . . and how to solve them: *Air, Water* and *Industry* is a pocket-size, 20-page booklet written for maintenance and production people. It tells in a simple way the story of moisture in air lines, how it gets there and what should be done about it. Van Products Co., Erie, Pa.

Circle No. **30** *on Reply Card*

Expansion Joints

. . . their construction and how to use them: *Catalog No. 53* gives, in 24 pages, the specifications and dimensions of Hydrolastic expansion joints, application data for piping systems, and how to order these hydrostatically-formed bellows. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

Circle No. **31** *on Reply Card*

Glass Coated Steel

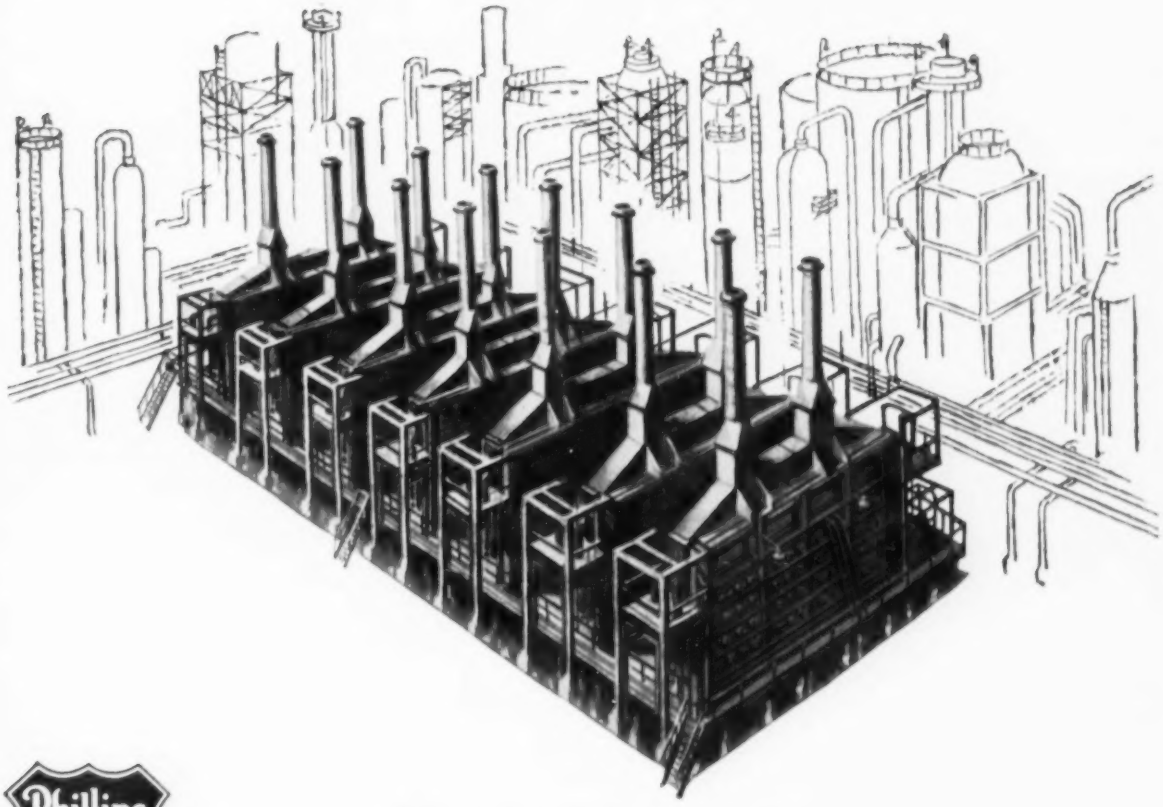
. . . resists the corrosive action of acids: *Bulletin 928* examines the resistivity of this material under many conditions of time, temperature and concentration. Colored charts present the test results for nitric, acetic, sulphuric, hydrochloric and phosphoric acids. Pfaudler Co., Rochester, N.Y.

Circle No. **32** *on Reply Card*

Petoleum Waxes

. . . and their expansion: *Coefficient of Volume Expansion for Petroleum Waxes and Pure n-Paraffins,* is the title of a paper reporting fundamental

IN ETHYLENE PRODUCTION...



Phillips 66 *too, will soon benefit*
...from SELAS Gradiation® Heating

A battery of seven Gradiation Heaters is now in the engineering stage at Selas for use in Phillips' new ethylene plant at Sweeney, Texas.

Based on their previous experience with Selas Heaters in ethylene service, Phillips knows it can expect:

- Operation at the designed capacity from the moment of startup.
- "On stream" periods, without shutdown, well in excess of 30 days.
- High conversions and selectivity.
- Versatility in processing widely different feed stocks.
- Zone Control of heat input, which enables meeting any time-temperature curve in pyrolytic or catalytic reactions and high temperature preheating.
- Uniform heat distribution on the entire tube surface extends tube life by eliminating local overheating and material degradation at the tube wall.
- Controlled combustion, with little or no excess air to cause external oxidation of the tubes . . . no lag in response to controller demand.

Send for copy of reprint, "Try the Gradiation Heater for Economical Ethylene Production" and Bulletin 95 "Gradiation Heating for Petroleum and Chemical Processing."

SELAS
CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

Heat and Fluid Processing Engineers
DEVELOPMENT • DESIGN • CONSTRUCTION

For Laboratory Apparatus you can trust...

Look to LINDBERG

Rugged . . . accurate . . . dependable

These are qualities you can be assured are built into the complete line of laboratory apparatus made by Lindberg.

The Lindberg units illustrated here are called "The Royal Family of Laboratory Apparatus." They include:

- . . . G-10 Laboratory Box Furnace (3000° F. Max.)
- . . . B2, B6 Laboratory Box Furnace (2000° F. Max.)
- . . . Laboratory Pot Crucible Furnace (2000° F. Max.)
- . . . Laboratory Hot Plate
- . . . Volumetric Carbon Determinator
- . . . "H-F" Combustion Unit
- . . . Sulfur Determinator
- . . . Laboratory Furnace Controls
- . . . Combustion Tube Laboratory Furnace

All these units are sold exclusively through your Laboratory Equipment Dealer. Consult him when you need laboratory apparatus—his advice and assistance will help you make the right selection for your needs. Or, for further information, write us for our Bulletin No. 1001, which describes in detail the complete line of Lindberg Laboratory Apparatus.

LINDBERG LABORATORY DIVISION

LINDBERG ENGINEERING COMPANY

2481 West Hubbard Street, Chicago 12, Illinois

knowledge gained on API Research Project 42. Many commercial uses of waxes depend on their temperature-sensitive properties of a functional nature. In this report are the results of volume measurements of paraffin and microcrystalline waxes and for one semipure and six pure *n*-paraffin hydrocarbons. Mellon Institute, 4400 Fifth Ave., Pittsburgh 13, Pa.

Circle No. **33** *on Reply Card*

Concrete Gunning

. . . equipment and how it works: *Form No. 156* gives complete details, specifications and operating capacities for this equipment. Included are many pictures showing how air-placed or gunned-concrete jobs are done; answered are many of the questions often asked about this method of constructing or repairing concrete structures. Air Placement Equipment Co., 1005 W. 24th St., Kansas City 8, Mo.

Circle No. **34** *on Reply Card*

Radioisotope Catalog

. . . issued by Oak Ridge National Laboratory lists 100 different radioactive preparations available. Special sections of the book are devoted to descriptions of the irradiation facilities in use, procedure for procuring isotopes, shipping information, neutron-activation analysis, and the Laboratory's waste disposal service for users. A copy may be obtained by writing to: Oak Ridge National Laboratory, Union Carbide Nuclear Co., Radioisotope Sales Dept., P. O. Box P, Oak Ridge, Tennessee.

Do Not Use Reply Card

Molybdenum Silicides

. . . and their applications for high temperature purposes: *Bulletin Cdb-6* consolidates information from 52 reference sources on the various molybdenum silicides. Included are details on preparation, applications, and chemical, physical and mechanical properties of this new class of refractory compounds. Climax Molybdenum Co., 500 Fifth Ave., New York 36, N.Y.

Circle No. **35** *on Reply Card*

Automatic Metering

. . . for small batching of light or heavy liquids: *Bulletin FL-56* describes the Fluidometer system, a volumetric automatic metering for batching liquids. It consists of three parts: the automatic resetting control head; a

Thousands of pressure vessels like these have been produced for the A.E.C. by Newport News, ahead of contract delivery schedule. Nickel-plated inside and out, they withstand corrosive uranium-hexafluoride gas.

When the pressure's on for pressure vessels

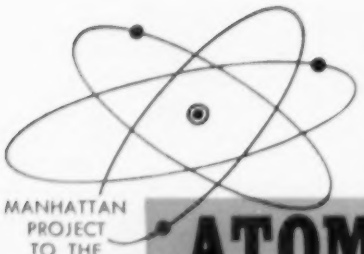
Specialized production techniques and the skill of Newport News craftsmen operating vast fabricating shops team up to deliver trainloads of pressure vessels on schedule.

When it comes to turning out process equipment, Newport News has the facilities and experience. So get a bid from Newport News on your present or future projects. Get the benefit of plant methods developed by specialists producing pressure vessels, vacuum tanks, towers, reactors, weldments and sub-assemblies.

Look over the scores of ways in which Newport News can help you . . . send for the easy-to-read, illustrated booklet *Facilities and Products*. It's yours for the asking.

Engineers: Desirable positions available at Newport News for Designers and Engineers in many categories. Address inquiries to Employment Manager.

Newport News
Shipbuilding and Dry Dock Company
Newport News, Virginia



CATAWISSA
PERFECT SEAL UNIONS
HAVE HAD A PART IN
EVERY APPLICATION OF

ATOMIC POWER

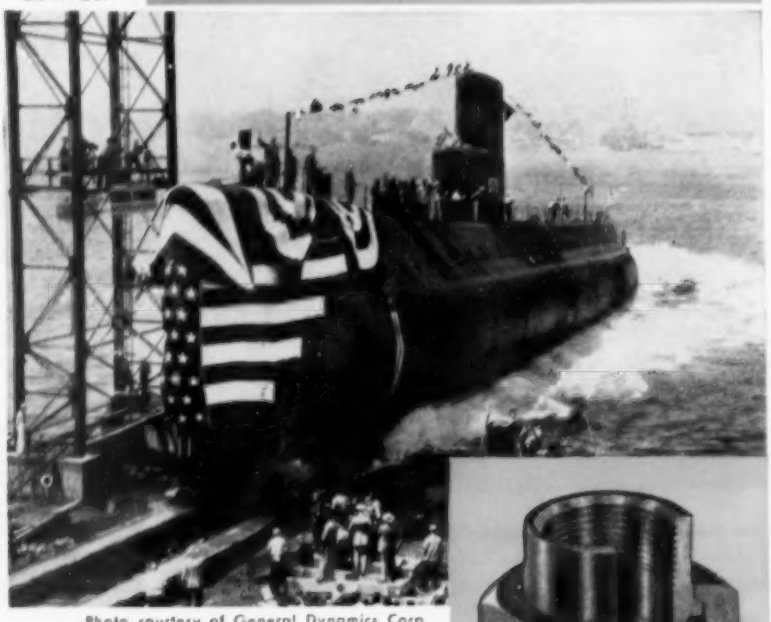


Photo courtesy of General Dynamics Corp.

LAUNCHING THE U.S.S. SEAWOLF at Groton, Conn., marked the development of the second atomic powered submarine built for the U.S. Government. Catawissa Valve & Fittings Co. is proud of its role in the project as major suppliers of Forged Steel Pipe Unions for the "Seawolf" — another repeat order in the atomic field . . . proof positive of satisfactory service!

SAFETY IS A "MUST"

From the original "Manhattan Project" to the U.S.S. Seawolf (and other unannounced atomic developments in private quarters), Catawissa Perfect Seal Pipe Unions have been specified to handle the extreme pressures involved. These are examples of "the toughest jobs", where absolute safety is a "must"!

3-TO-1 SAFETY FACTOR

One of the many extra value features of Catawissa Unions is in the very design itself — a design which gives each union a 3-to-1 safety factor. Catawissa 3000-lb. service unions, for example, are tested to 9000-lbs.; 6000-lb. service unions are tested to 18000-lbs., etc.

This point of superiority, plus expert workmanship and 40 years of experience, make Catawissa Forged Steel Pipe Unions and Swing Check Valves the best buy for rugged, trouble-free service wherever dependable performance is required.

PERFECT SEAL SEATING

Another Catawissa exclusive is its Ball-to-Angle seat design, which assures a Perfect Seal even when the two pipes joined are not in alignment.

ALL PRESSURES, TEMPERATURES

The Catawissa line is the most complete line of unions on the market—regular or special! They're hot forged from solid bars of AISI Spec. C-1026 steel, and meet the requirements of ASTM Spec. A-105, Grade 2.

YOU CAN TAKE THE GUESSWORK OUT OF PIPING PROBLEMS

. . . specify CATAWISSA Perfect Seal Pipe Unions & Swing Check Valves • AT YOUR FAVORITE SUPPLY STORE •

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNA.

meter of suitable size, type and materials, and a control valve. All three may be assembled in a closely or remotely related grouping. Hetherington & Berner Inc., 701 Kentucky Ave., Indianapolis 7, Ind.

Circle No. **36** *on Reply Card*

Pipe Insulation

. . . made of hydrous calcium silicate and marketed as "Thermobestos": *Booklet IN-169A* gives information on this insulation for hot outdoor piping and process equipment, at temperatures up to 1200°F. Made from asbestos, diatomaceous silica and lime, it is chemically stable, non-inflammable, has low conductivity and is not damaged by water. Included are sections on physical and thermal properties, heat transmission tables for both pipe and block insulation and tables of available sizes and thicknesses. Johns-Mansville, 22 E. 40th St., New York 16, N.Y.

Circle No. **37** *on Reply Card*

Fluorcarbon Rubber

. . . functions successfully at high temperatures and under corrosive conditions: *Kel-F Elastomer* is a 16-page booklet describing the unusual physical properties of this fluocarbon rubber. Showing extreme resistance to acids, ozone and other oxidants, even at high temperatures, the elastomer is supplied for fabricating on existing rubber production facilities. Applications include hose, diaphragms, gaskets, linings, electrical insulation, and many other uses where corrosion resistance is required. M. W. Kellogg, Chemical Manufacturing Div., P. O. Box 469, Jersey City 3, N.J.

Circle No. **38** *on Reply Card*

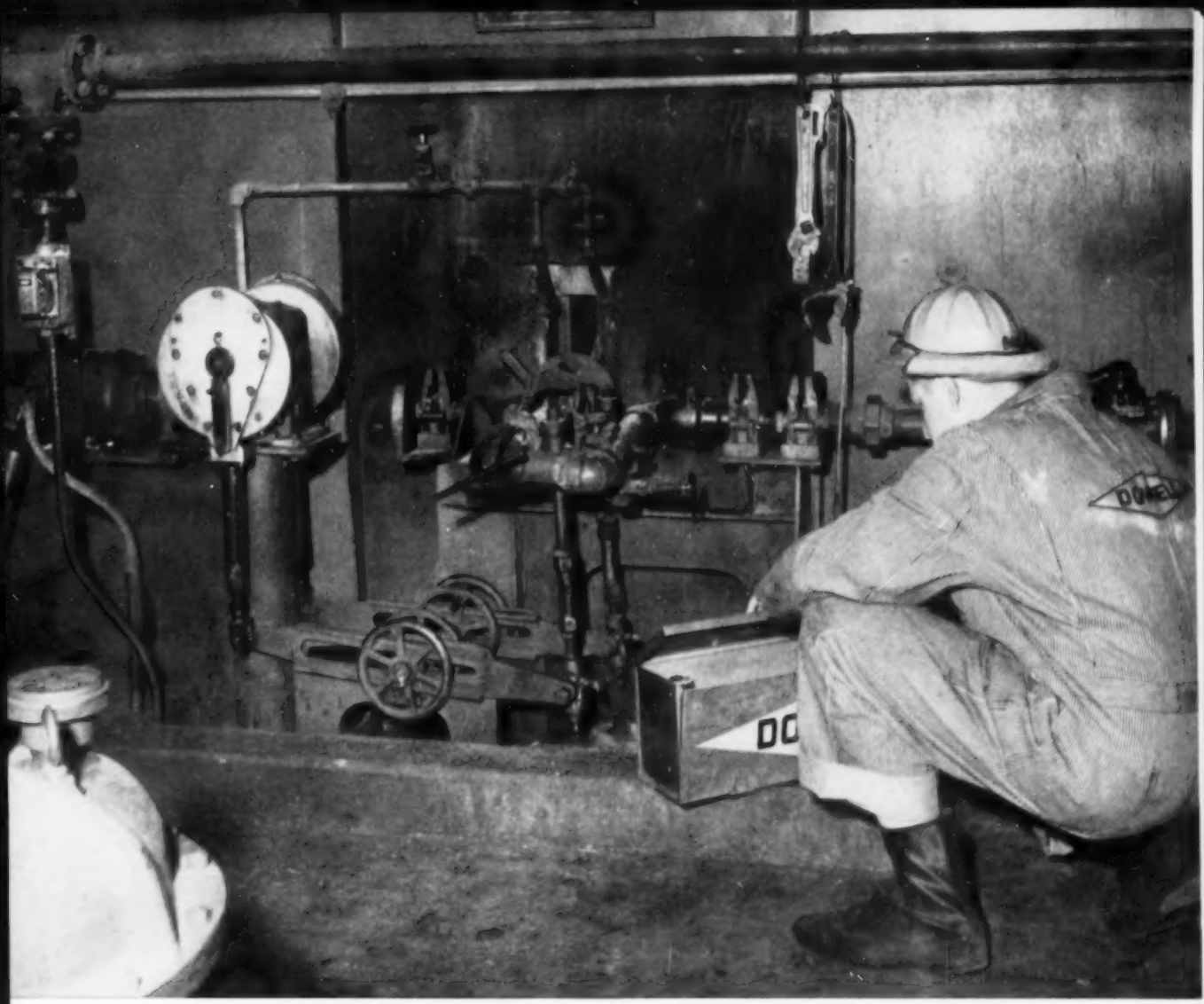
Pipe Nipple Catalog

. . . carries complete information for every class of nipples: in 16 pages, *Catalog 755* lists prices, carton quantities, weights and ASTM specifications for welded steel, seamless steel, wrought iron, stainless steel, plastic, aluminum, red brass and many other types of nipples. Pittsburgh Nipple Works, Inc., 1455 Spring Garden Ave., Pittsburgh 12, Pa.

Circle No. **39** *on Reply Card*

High Pressure Pumps

. . . in over 100 models cover three standard pressure ranges: 0-3000 psi, 0-5000 psi, and 0-8000 psi. *Bulletin P-55* shows the five basic cylinder designs of these pumps, includes graphs



The risk is too great —clean it right

You don't take risks when men, equipment, and lost production time are involved. That's why more and more companies are investigating the methods and firms used in their chemical cleaning. They know it's work for experts.

What are they concerned about?

First, they want to know they are getting the benefits of experience. These benefits include less downtime and more thorough cleaning. Dowell has this experience with over 15 years and 10,000 boilers alone to their credit. In saving downtime, Dowell often cleans equipment while it is in operation.

Next, these companies want to be sure their men and equipment have the greatest possible protection. Dowell excels here, too. For safety is foremost in the Dowell engineer's mind. Thoroughly trained, he uses only the latest safety methods and equipment. He works closely with your safety personnel to establish safest possible working procedures.

Be sure you are getting maximum results with maximum protection in your chemical cleaning.

Call the Dowell office near you. Dowell engineers are ready to discuss and help you with your cleaning problems any time, at no obligation. Or write Dowell Incorporated, Tulsa 1, Oklahoma, Dept E-32.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

BOWSER

SYSTEMS SPEED PROCESSING TO CUT PRODUCT COST

METERS FILTERS

Metering and filtering of liquids from bulk receipts through delivery assure quantity and quality control.

BLENDERS DEHYDRATORS

Closed system proportioning and blending of liquid stocks plus continuous dewatering where needed, deliver a better end-product at lower cost.

Write for Catalogs

All equipment available on lease or purchase payment program . . .

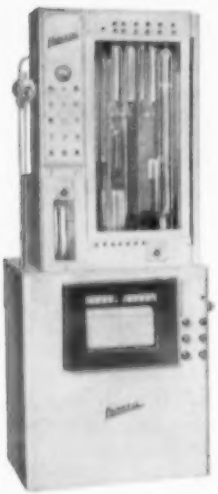
REGIONAL OFFICES: ATLANTA · BOSTON CHICAGO · CLEVELAND · DALLAS · KANSAS CITY LOS ANGELES · NEW YORK

BOWSER, INC., 1329 E. Creighton, Fort Wayne, Ind.

BURRELL "For Scientists Everywhere"

THE FRACTON®

FOR ANALYSIS OF LIGHT HYDROCARBONS



For: NATURAL GAS
GASOLINE PLANT GASES AND LIQUIDS
REFINERY GASES
CYCLING PLANT GASES
LIQUEFIED PETROLEUM GASES
SYNTHETIC RUBBER INTERMEDIATES
PLASTIC INTERMEDIATES
PETROCHEMICAL GASES
and other light hydrocarbons

THE FRACTON CUTS ANALYSIS TIME AND EXPENSE, IMPROVES ACCURACY AND IS EASIER TO OPERATE

The Fracton separates, identifies, collects and measures the components and records the analytical data in fifty to seventy-five percent less time than former methods. Users get superior accuracy and reproducibility with this new, improved and simplified instrument.

Request Your Copy of Booklet No. 82

®Trademark Registered U.S. Patent Office

BURRELL CORPORATION
Scientific Apparatus and Laboratory Supplies
2223 Fifth Avenue, Pittsburgh 19, Pennsylvania

covering their selection and typical power curves, and illustrated data on their construction and operation. Manton-Gaulin Mfg. Co., 44 Garden St., Everett 49, Mass.

Circle No. **40** *on Reply Card*

Two New Instruments

. . . now available for lab analysis of gasoline and other petroleum products: *Bulletin FS-247S* describes the Fisher Coulomatic Titrimeter, an instrument for analyzing mercaptans in gasoline, traces of halides, and a variety of other substances including cobalt, nickel, iron, permanganate and thiosulfate. It has a series of interchangeable electrodes that permit wide analyses. *Bulletin FS-255* describes the Fisher-Gulf Partitioner, an instrument for gas-liquid partition chromatography. It permits quantitative and qualitative analysis of hard-to-separate hydrocarbons. Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.

Circle No. **41** *on Reply Card*

Heat Transfer

. . . building blocks: *Catalog HT-23* is a reference guide on the use of National Sections used to build cooling and condensing systems for process fluids. Included are data on their use in refineries and gas plants, and their physical characteristics for design purposes. One section of the catalog deals with thermal design, presenting the solution to a typical process problem. National-U. S. Radiator Corp., 342 Madison Ave., New York 17, N.Y.

Circle No. **42** *on Reply Card*

Welding and Heat Treating

. . . of high-strength carbon and alloy steels: *Heat Treatment of Air Hardening Alloys on Welding*, a 12-page report on the subject of postweld heat treatment and the influence of weld preheating temperature on hardness and microstructure of heat treated welds of air hardening alloys. Tubular Products Div., Babcock & Wilcox Co., Beaver Falls, Pa.

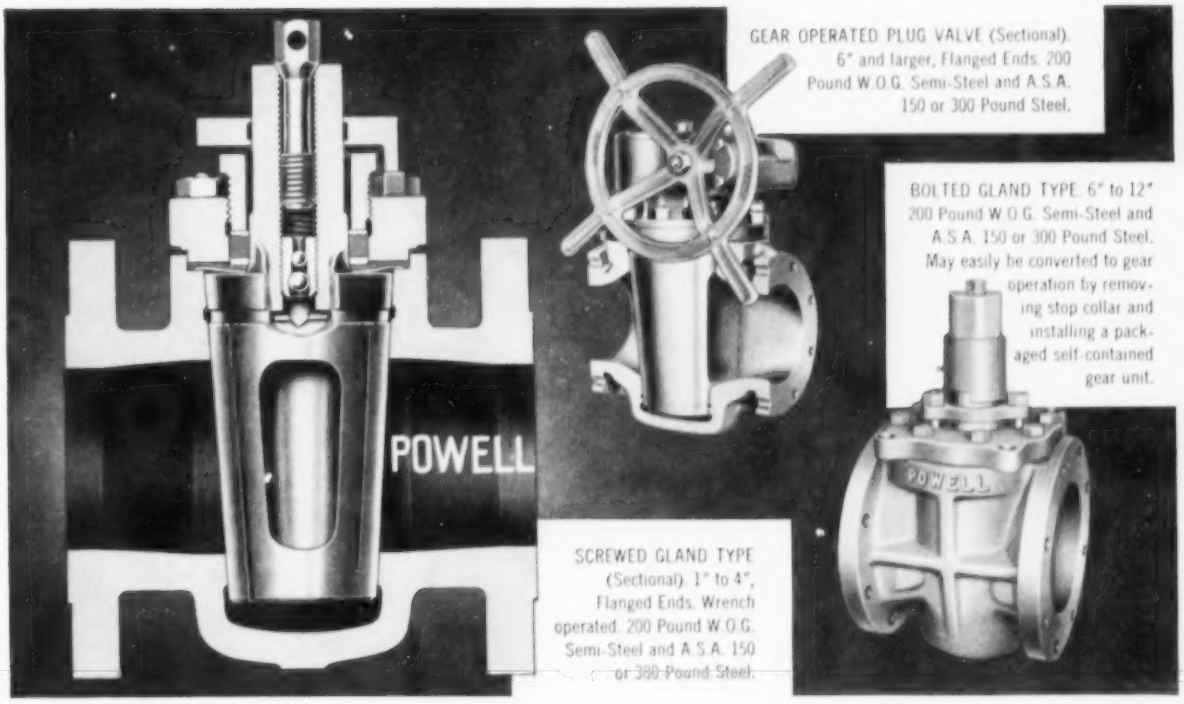
Circle No. **43** *on Reply Card*

Metallic Stearates

. . . their properties and uses: *Bulletin No. 55-2* lists the composition of 46 metallic stearates, shows graphically the industries in which they are used, and presents an analysis of recommended applications. Some of these include: aluminum stearate for greases and lubricating oils, lead stearate as

POWELL

Lubricated Plug VALVES



GEAR OPERATED PLUG VALVE (Sectional). 6" and larger, Flanged Ends. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

BOLTED GLAND TYPE. 6" to 12" 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel. May easily be converted to gear operation by removing stop collar and installing a packaged self-contained gear unit.

SCREWED GLAND TYPE (Sectional). 1" to 4", Flanged Ends. Wrench operated. 200 Pound W.O.G. Semi-Steel and A.S.A. 150 or 300 Pound Steel.

Powell Lubricated Plug Valves maintain our 110-year tradition of quality and precision. Only the finest available materials are used. And painstaking quality control is rigidly enforced through each and every step of manufacture.

Features include quick and positive operation—just a quarter-turn to open or close. Lubricant grooves surrounding each port provide a positive seal when the valve is closed. In an open position, seating surfaces are not exposed.

Valve users who want one source of supply for lubricated plug as well as all types of bronze, iron, steel and corrosion-resistant valves will want full details on Powell Lubricated Plug Valves.

Available in Steel and Semi-Steel through distributors in principal cities. If none is located near you—or if you need help on valve problems—write direct to

PERFORMANCE PV VERIFIED

BRONZE, IRON, STEEL AND CORROSION-RESISTANT VALVES

The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR

The source of supply for all valve needs!

(To obtain more data on advertised products see page 174)

Extra-Handy...and tough all the way through!

8 sizes, ⅛" to 6" pipe.

RIDGID

the easy-to-use Bench Pipe Vise

Look at the *more* you get for your money... built-in pipe rest aids accurate threading, handy pipe bender . . . LonGrip tool-steel jaws hold pipe firmly without chewing it up . . . yoke and base of special last-a-lifetime malleable...a bargain in quality! Order from your Supply House today.

THREADED PIPE — *It's Tight • It's Best • Costs Less*

RIDGID
Work-Saver Pipe Tools

The Ridge Tool Company, Elyria, Ohio, U.S.A.

part of a rust preventative, and lithium stearate as in synthetic greases. Copies of the bulletin may be obtained upon letterhead request to Witco Chemical Co., 122 E. 42nd St., New York 17, N.Y.

Do Not Use Reply Card

Electrical Bulletins

. . . catalog special equipment available from the manufacturer: 28-page bulletin, *GEA-4746B*, covers the complete line of control and transfer switches for low voltage applications up to 600 volts AC or DC. Application data, representative contact diagrams and ordering directions are included. *Bulletin GEC-1005G*, a 60-pager, contains application index, calculating data, operating information and list prices for heaters and heating devices. General Electric Co., Schenectady 5, N.Y.

Circle No. **44** *on Reply Card*

Did You Miss These?

The following items, reviewed originally in January, have aroused considerable interest among readers. They are repeated here briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

Indirect Heater Manual

. . . tells how to size indirect heaters for oil and gas service. *Delta Indirect Heaters Sizing Manual* includes typical solutions to heater problems, along with working charts and monographs. Delta Tank Manufacturing Co., Inc., Oil Equipment Div., Baton Rouge, La.

Circle No. **45** *on Reply Card*

Ethylene Production

. . . via the steam pyrolysis process: new booklet describes with flow charts and an economic breakdown table the advantages of this process for producing ethylene from a residual oil charge. Chemical Process Division, M. W. Kellogg Co., 225 Broadway, New York 7, N.Y.

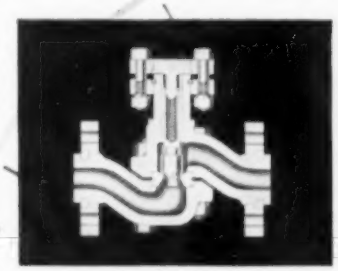
Circle No. **46** *on Reply Card*

pH Control Handbook

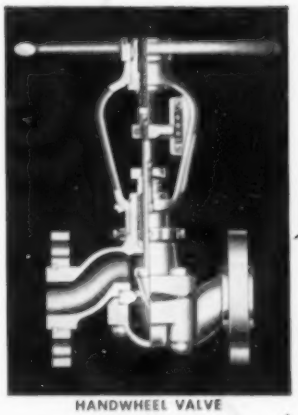
. . . includes the theory and practice of colorimetric analysis. The pocket-size, 100-page booklet, *Modern pH and Chlorine Control*, is a handy reference for quantitative determinations

(To obtain more data on advertised products see page 174)

AROUND-THE-CLOCK RELIABILITY with Annin

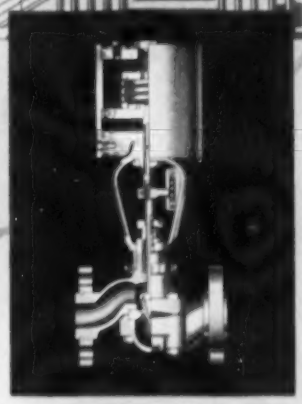


CHECK VALVE



HANDWHEEL VALVE

DOMOTOR VALVE



CYLINDER VALVE

Yes, *Annin* offers design and control engineers a complete line of valves for rugged and reliable performance "around-the-clock." Name the installation—rocket stand, aircraft component test facility, chemical plant, refinery, paper mill or power plant—and *Annin* valves will exceed the most critical performance needs, with features like:

- Piping flexibility
- Pressure ratings to 10,000 PSI
- Body designs for gases to molten metals
- Temperatures from −400°F to +1600°F
- Interchangeable operators—Domotor, Cylinder or Handwheel

ANNIN'S new and comprehensive valve catalog 1500-C is now ready for distribution. Send for your copy today.

ANNIN

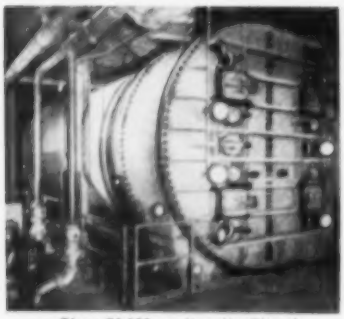
THE ANNIN COMPANY

6570 EAST TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA

Control VALVES

(To obtain more data on advertised products see page 174)

The BIGGER the BETTER



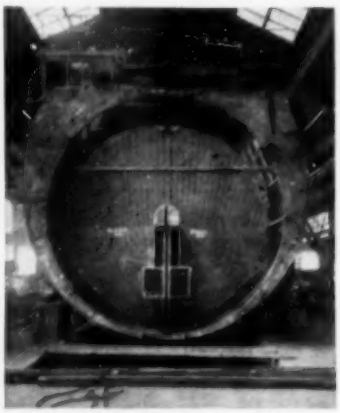
Three 70,000 sq. ft. units, City of Los Angeles, Cal.

One 45,000 sq. ft. unit and two 20,000 sq. ft. units, Puerto Rico Water Resources.

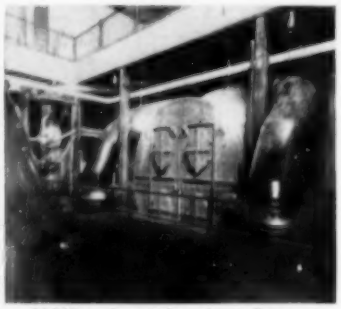
28,000 sq. ft. unit, City of Owensboro, Kentucky.

CONSECO

CONDENSERS



33,000 sq. ft. unit, Penn Power Company, Newcastle, Pa. Under Construction.



33,000 sq. ft. unit Penn Power Company, Newcastle, Pa. Installed.

OTHER INSTALLATIONS INCLUDE

One 30,000 sq. ft. unit, Northern Sate Power Corporation.
One 35,000 sq. ft. unit and three 12,000 sq. ft. units, for Dairyland Power Corporation.

UNDER CONSTRUCTION

One 45,000 sq. ft. unit for Transit Authority, N. Y. C.
One 35,000 sq. ft. unit for Maryland Power Corporation.
One 27,000 sq. ft. unit for City of Detroit, Michigan.

NO matter what size units you need, CONSECO gives you what it takes to produce them . . . experienced engineering, sound design, dependable manufacture, better performance . . . at lowest ultimate cost.

CONSECO DESIGNS AND BUILDS

Heat Exchangers • Condensers • Evaporators • Steam Jet Air Ejectors • Steam Generators • Pressure Vessels • Centrifuges • Filters • Strainers • Pumps • Instruments and Specialties.

CATALOGS ON REQUEST

CONDENSER SERVICE & ENGINEERING CO., INC. CONSECO

Designers and Builders of Equipment for Power, Refining, Chemical and Marine Industries

54 BLOOMFIELD STREET
HOBOKEN, N. J.

of pH, chlorine, bromine, phosphate, nitrate, sulfite, hardness and other special tests. Slide comparators and complete test kits are illustrated. W. A. Taylor Co., 7300 York Rd., Baltimore 4, Md.

Circle No. **47** *on Reply Card*

Platforming Catalysts

. . . tailored for producing gasolines of 98 leaded octane number and higher are now available. "UOP Type R-7 and Type R-8," the improved catalysts, are of low density and high activity. Their shape is spherical but smaller in size than the present line of catalysts. In the production of high octane number gasolines they are reported to give increased yields, with more hydrogen and less carbon than presently available catalysts. Type R-8, available under special arrangement, has a higher platinum content. Universal Oil Products Co., Des Plaines, Ill.

Circle No. **48** *on Reply Card*

Porous Stainless Filters

. . . operate under severe conditions: temperatures to 1200°F, pressures of 2000 psi, and with corrosive liquids or gases. Produced from spherical powdered stainless steel alloys, the filter elements are available in either cylindrical or cell type shapes. For unusual conditions, custom engineered filters are available made from the same material.

The "Poro-Klean" elements have the following properties: tensile strength (ultimate) 9000 to 25,000 psi; % elongation, 3 to 6%, and per cent of porosity, 30 to 50%. Particle size retention grades from 3 to 30 microns. Cuno Engineering Corp., Meriden, Conn.

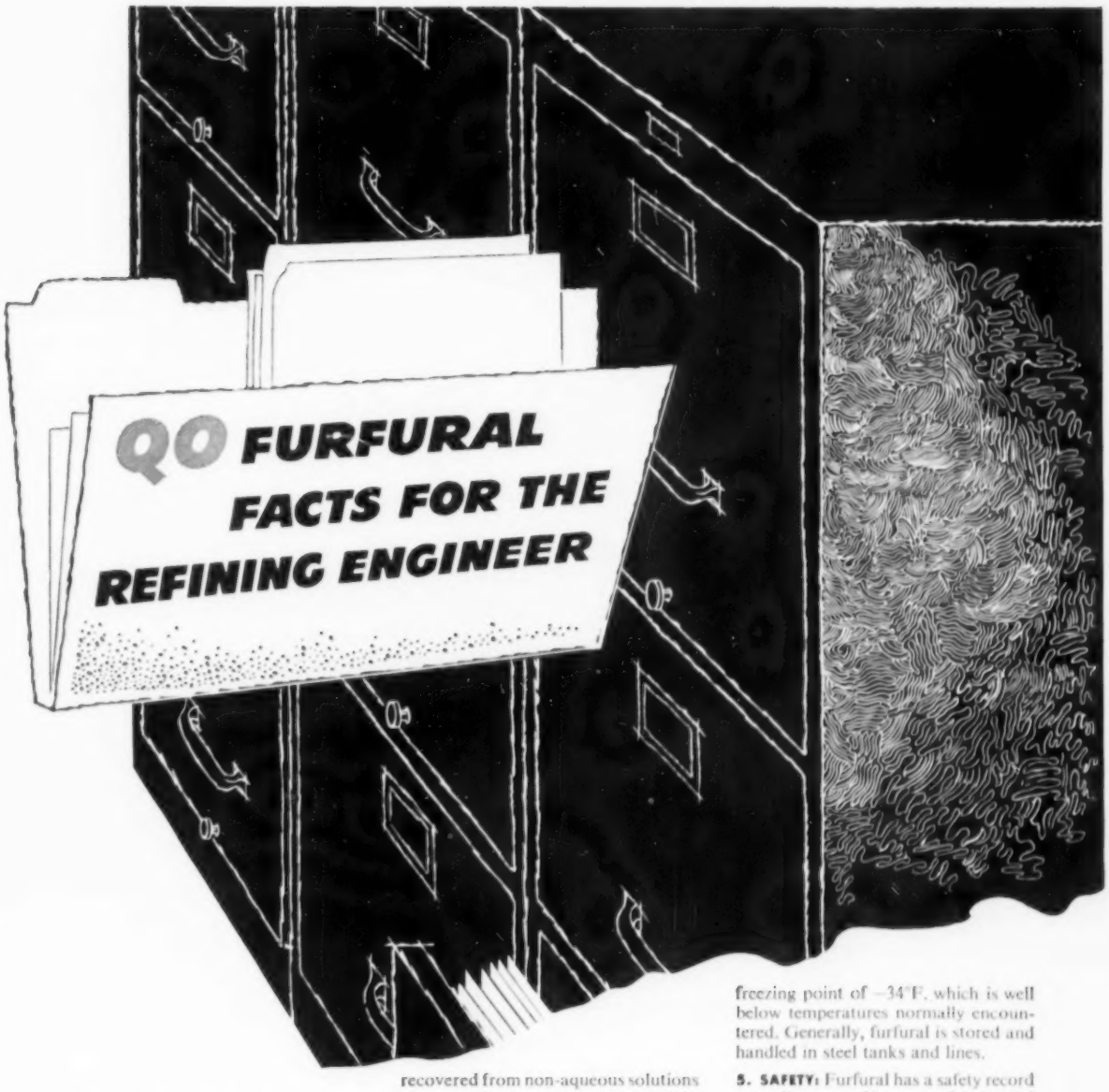
Circle No. **49** *on Reply Card*

Diaphragm Valve

. . . allows straight-through flow for viscous materials or slurries. This weir type diaphragm valve will close firmly even when handling gritty or fibrous materials. The separation of the replaceable diaphragm from the bonnet means simple maintenance. There is no packing gland or disc holder with a metal-to-metal seat. If it is necessary to rod or brush out the line, removing the valve bonnet is not required. The diaphragm may be withdrawn completely from the pipe inner diameter. Grinnell Co., Inc., Saunders Valve Dept., 260 West Exchange St., Providence 1, R.I.

Circle No. **50** *on Reply Card*

(To obtain more data on advertised products see page 174)



What Makes Furfural So Good As a Selective Solvent?

1. SELECTIVITY: Furfural is highly selective; it is a polar molecule and gives a sharp separation. Its high specific gravity permits rapid phase separation.

2. EASE OF RECOVERY: Furfural may be readily recovered from aqueous solution by steam stripping; it may be recovered from non-aqueous solutions either by flash vaporization, straight distillation, steam stripping, or extraction with water.

3. STABILITY: Under the conditions encountered in refining, furfural has a high degree of stability, as shown by the low solvent losses in operating plants around the world.

4. STORAGE: It is not necessary to use special handling precautions for cold weather operation since furfural has a freezing point of −34°F. which is well below temperatures normally encountered. Generally, furfural is stored and handled in steel tanks and lines.

5. SAFETY: Furfural has a safety record extending over 30 years of industrial use. It has a high flash point (150-160°F.), and a vapor pressure of 8 mm. Hg at 39.9°C.

6. COST: Furfural is low in price, and with high recovery, overall solvent costs are attractively low.

7. AVAILABILITY: Large quantities of furfural are produced the year around at three plants from raw materials which are replaceable yearly.

If you would like to know more about the properties of furfural, write for our Bulletin 203 "Physical Data on Furfural."

The Quaker Oats Company — **CHEMICALS DEPT.**

3398 The Merchandise Mart, Chicago 54, Illinois
Room 5398, 120 Wall St., New York 5, N. Y.
Room 4398, P. O. Box 4376, Portland 8, Oregon
In the United Kingdom: Imperial Chemical Industries Ltd., Billingham, England • **In Europe:** Quaker Oats-Graanproducten N.V., Rotterdam, The Netherlands, Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota", Copenhagen, S. Denmark
In Australia: Swift & Company, Pty., Ltd., Sydney • **In Japan:** F. Kanematsu & Company Ltd., Tokyo

THE SHORTAGE OF SCIENTISTS AND ENGINEERS:

How Critical Is It?

The United States is running into a serious shortage of scientists and engineers. There is no novelty in this observation. It has often been made in the last few years. And there has been mounting alarm about what this shortage may mean for both our national security and our prosperity.

There would be great novelty, however, if general agreement were attained on such important matters as the size of the shortage, the extent of the damage it threatens to inflict, and the best ways to eliminate it. The purpose of these editorials is not to provide this novelty, but to ventilate some of the key aspects of the shortage of scientists and engineers.

This first editorial in the series is designed to throw light on the over-all dimensions of the shortage. Others to follow will be addressed to such questions as:

- How serious is the threat to our economic well-being and to our national security?
- What needs to be done to prevent the shortage from becoming critical?

Rise Has Been Rapid

The problem is *not* that we have been producing a small number of engineers and scientists. Indeed, the number has risen sharply. We now have a working force of more than 600,000 engineers, over twice as many as the 286,000 there were in 1940. And we have about 250,000 scientists (chemists, physicists, biologists, geologists, mathematicians, etc.), compared to only 92,000 in 1940. About one in 148 persons in the labor force of 1940 was a scientist or engineer; today the ratio is about one in every 80.

In research and development work, where highly creative scientific minds are required, there has been fully as rapid a rise in employment of scientists and engineers. Fewer than 90,000 were employed in research and development fifteen years ago; the total now exceeds 200,000.

—But Not Rapid Enough

Despite this rapid increase in the number of scientists and engineers—at a rate much faster than the increase in the labor force as a whole—the needs of industry, government and education for technically trained people have risen even more sharply.

The principal reason for this mounting demand is the prodigious growth of research in the last 15 years. From a total of only about $900 million spent on all types of research in 1941, the annual expenditure rose to over $5 billion by 1953 (the latest estimate available). Over two-thirds of the research is done by private industry, mostly to develop new and better products and to find new and better methods of production. Most of the rest is performed by the government, largely to develop improved and inevitably more complex scientific weapons.

One aircraft company has found from its own experience that it required 17,000 engineering manhours to develop a typical fighter plane in 1940. The requirement is now about 1.4 million engineering manhours. Development of the typical fighter plane of 1960 will require well over 2 million engineering manhours.

In this dramatic example, the need for engineering services for a basic piece of military equipment soared 80 times in 15 years. It is an indication of why the demand for more and more technically trained men and women has outstripped even the imposing increase in scientific and engineering manpower of the last decade and a half.

Size of the Gap

Exactly how great the gap is between the available supply of scientists and engineers and the number required, it is impossible to say. In some instances technical talent undoubtedly could be better used than it is now. And part of the shortage might "disappear" if higher salaries had to be paid. (These questions will be discussed in later editorials.) But informed estimates of the approximate size of the gap can be given.

- According to the best available information, from estimates by the Engineers' Joint Council and the U. S. Bureau of Labor Statistics, **the minimum need for engineers from graduating classes is 40,000 each year for the next ten years.** Last year we graduated only 23,000 engineers, just about enough to cover replacement needs without allowing for any expansion of the number of active engineers. Projections made by the U. S. Office of Education indicate that we shall probably not have a class of 40,000—the *current* annual requirement—until 1963.
- According to Dr. Howard Meyerhoff, executive director of the Scientific Manpower Commission, **there is now a shortage of about 20,000 scientists.** Last year the number of doctoral degrees in the natural sciences, almost a prerequisite for research work, was only 5,000. Dr. Meyerhoff estimates that the shortage of scientists will rise another 30,000 by 1960.

More Needed As Teachers

Not all of the graduates with scientific and engineering training, furthermore, will work as scientists and engineers—that is, by performing research and giving it practical application. Such training is now necessary in many sales and management positions. And more of our technically trained men and women must remain in educational institutions as teachers if the quality of engineering and scientific education is to be maintained. A survey in 1954-55 by the National Education Association showed that, out of 277 universities, state colleges and large private colleges, nearly one-third *already* had unfilled vacancies in engineering and three-fourths had vacancies in physical sciences.

The dimensions of the shortage of scientists and engineers can be summarized as follows: **Despite a substantial rise in the trained manpower available, the needs of industry, the government and education have risen still faster. The best information indicates that, on the basis of current and anticipated needs, our recent yearly rates of production of slightly over 20,000 engineers and about 5,000 PhD's in natural sciences could be doubled without closing the gap entirely.**

The disturbing implications of this shortage for our national security and our prosperity and some practical suggestions for eliminating it will be the subjects of subsequent editorials in this series.

This is one of a series of editorials prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments of particular concern to the business and professional community served by our industrial and technical publications.

Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw

PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

EDITORIALS . . .

Top Level Decisions Are Needed — Now

ONCE upon a time there was a walrus. He was, and still is, a very famous walrus. And even though he was imaginary, he is often quoted.

If that creature were alive today and if he were to address a group of top executives in refining, he'd probably be quoted as saying something like this: "The time has come to speak of only one thing—how to extend the octane scale for motor fuels above 100."

All of which is a fanciful way to lead into a serious subject. The time **has** come, it seems to us, for refinery management in this country to give some serious thought to the matter of an extended octane scale. Questions of policy are now involved which can be settled only at the management level.

The facts are these: With our present octane scale, motor fuels cannot be rated above 100 octane. And fuels are rapidly approaching this limit. The average octane number of premium grade gasolines sold in the U. S. at the beginning of the year was 96.2. In Jan. 1955 it was 94.3. And remember, those are averages. Premium fuels of as high as 98.7 are reported in some areas.

A year ago, two technical groups undertook a study of the problem. One of these was the Coordinating Research Council—joint research agency of the American Petroleum Institute and the Society of Automotive Engineers. The other group was Committee D-2 on Petroleum Products of the American Society for Testing Materials. The results of their efforts are detailed elsewhere in this issue (pp. 90-92).

These two groups have carried out their assignment, and carried it out well. Briefly, they have proposed a rating method which uses iso-octane plus tetraethyl lead as a reference fuel, measures fuel antiknock quality in terms of performance number, and then relates that performance to an octane scale that goes from 100 to 120. They have come up with what is in many ways a workable solution. It retains the term "Octane Numbers" for expressing antiknock quality, standard test equipment can be used, and there is only a very small break with the existing scale at the 100 octane point.

Objections have been raised however. A large but undisclosed proportion of the full membership of the two groups has refused to approve the proposed scale for one reason or another. The basic objection put forth by refiners is the discrepancy between the lower and upper ends of the scale when a given numerical increase in gasoline quality is compared with the actual increase in quality. For example, one octane number at the lower end of the scale (from 100 to 101) is equivalent to about 0.07 cc. of TEL, but one octane number at the upper end (from 119 to 120) is equivalent to over 0.7 cc.—roughly 10 times as much TEL.

This same discrepancy works to the advantage of the automotive people. They can point to the greatly improved engine performance they are building into their engines at the cost of only one octane number advance in the antiknock quality of the motor fuel required.

Since so many of their members have turned thumbs down on the proposal, the committees do not feel that they can endorse the proposed scale and pass it along for approval at higher committee levels. Nor do they feel that they can come up with anything better if they reopen their work on the specific assignment to find a scale for antiknock valves above 100. A stalemate is rapidly developing.

To break this stalemate, it is now essential for petroleum industry leaders to arrive at some top level decisions. There are at least three main points to be decided:

1—What is the degree of urgency in finding an answer to the problem of rating commercial motor fuels above 100 octane? Just how soon will we need a bigger yardstick?

2—Should we adopt the new scale as proposed, and revise it if necessary as we go along—as we did with the existing scale in going from Motor Method to the Research Method?

3—Should we scrap the idea of an "octane" scale entirely above 80 or 90 octane, and go to some other method—such as performance numbers?

The need for answers to these questions is urgent—about that there can be no doubt. The automotive industry is going to build higher compression engines that will require better fuels. Refiners will turn out the fuels that are needed—and they'll measure them by whatever scale is in general use, or adopt one of their own choosing.

Top levels in the oil companies should promptly decide whether they want to adopt the proposed scale, or refer the matter back to the technical groups for more study. United in this matter they can more likely bring the automotive industry to follow the same procedure.

GENERAL CHEMICAL ANNOUNCES ANOTHER NEW PLANT TO PRODUCE SULFAN® FOR FASTER, BETTER SULFONATIONS, SULFATIONS

NEW YORK, N. Y.—A large, new plant for the production of "Sulfan" Stabilized Sulfuric Anhydride is now being built at Chicago, Ill., by General Chemical, making additional tonnages of this versatile sulfonating agent available to industry.

The new plant will augment production at General's present Buffalo, N. Y., plant, where production has been expanded repeatedly during the past six years to meet the ever-growing demand for this easy-to-handle liquid form of SO_3.

"The Calumet plant has become a necessity as more and more industries discover the advantages of 'Sulfan' as a faster, better means of conducting sulfonations and sulfations," the announcement stated.

Here's How Sulfan Can Benefit You!

Users in many fields have found that "Sulfan" lets them produce finer sulfonated products at lower costs. One notable example is provided by producers of "low-salt" liquid detergents who find that it eliminates their salt removal problem entirely. And there are many others in a score of industries who are turning to "Sulfan" because it—

1. Furnishes more than 99% available SO_3 in easy-to-handle liquid form.
2. Offers 9 times as much usable SO_3 as 100% Sulfuric Acid, and more than 3 times as much as 20% Oleum for many operations.
3. Is 100% active—every pound that goes into process can be utilized for sulfonating.
4. Frequently eliminates spent acid and its disposal problems.
5. Permits increased batch sizes or more rapid through-put—often as much as double—without increasing size of equipment.

Still other advantages and economies may be offered by "Sulfan" in your own operations. If you sulfonate or sulfate, it will pay you to get all the facts about "Sulfan" now. Phone or write . . .

Basic Chemicals for American Industry

GENERAL CHEMICAL DIVISION
ALLIED CHEMICAL & DYE CORPORATION

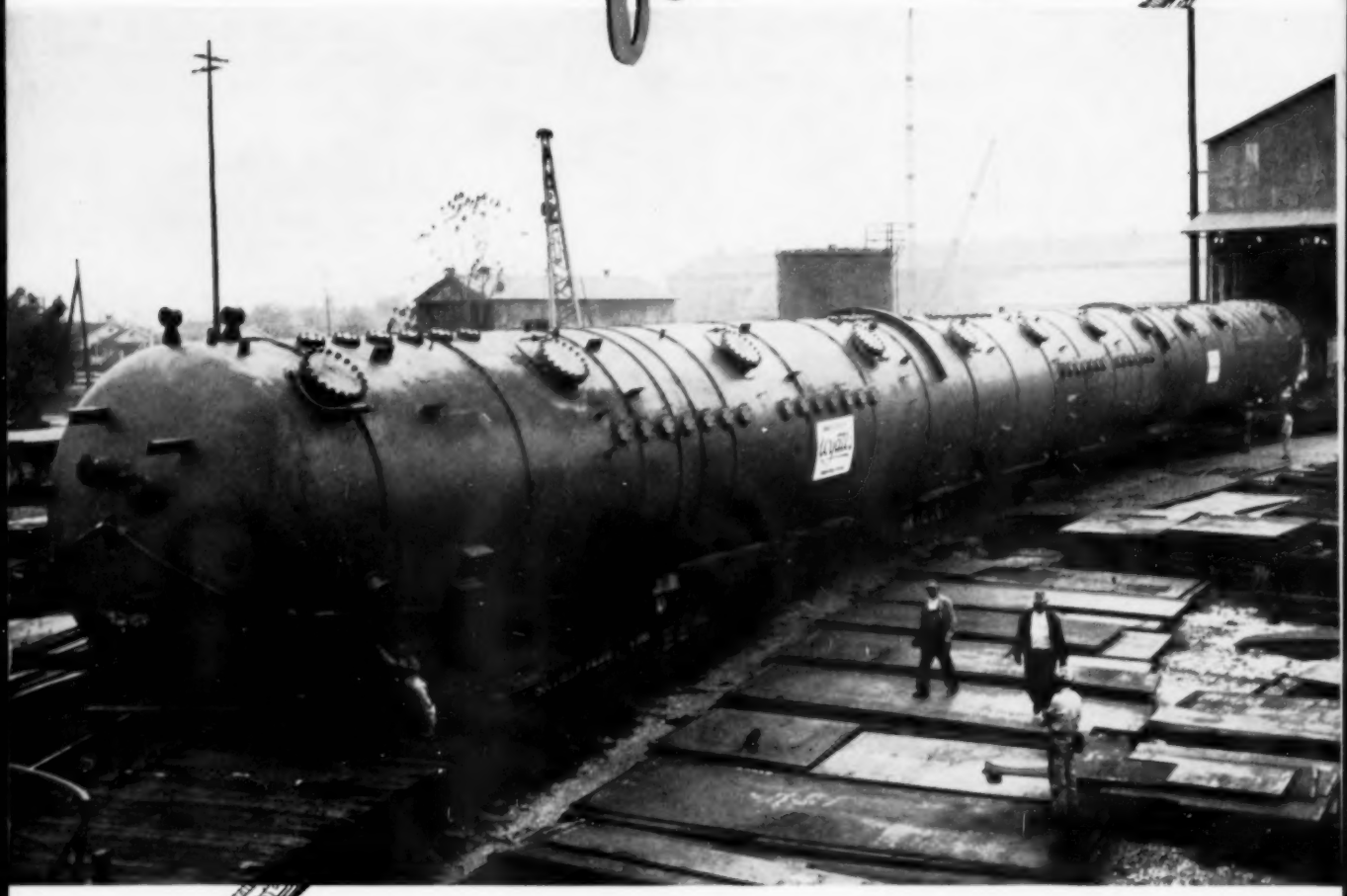
40 Rector Street, New York 6, N. Y.

Offices: Albany • Atlanta • Baltimore • Birmingham • Boston • Bridgeport • Buffalo • Charlotte • Chicago Cleveland • Denver • Detroit • Greenville (Miss.) • Houston • Jacksonville • Kalamazoo • Los Angeles Milwaukee • Minneapolis • New York • Philadelphia • Pittsburgh • Providence • San Francisco • Seattle St. Louis • Yakima (Wash.)

In Canada: The Nichols Chemical Company, Limited • Montreal • Toronto • Vancouver

*Stabilized Sulfuric Anhydride

Rail Record for Length



• This Tower, 203 feet overall, left Wyatt's Houston Plant on six flat cars and set a new load record for length for the area's railway facilities.

The vessel, 13 feet inside diameter, weighs 435,000 pounds.

Wyatt's
HOUSTON-DALLAS-NEW YORK-TULSA

MANUFACTURERS AND ERECTORS SINCE 1913